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INDEX TO VOLUME XXVIII.

October, 1904, to March, 1905.

LEADING ARTICLES.

Abbot, Gen. Henry L. The Revival of De Lesseps' Sea-Level Plan for the Panama Canal 721

Accidents on American Railways—The Causes of *F. W. Haskell* 321

Addenbrooke, G. L. Electric-Power Supply from Central Stations in Great Britain (Illustrated) 761

Air—The Mechanical Transport of (Illustrated) *Walter B. Snow* 541

Arnold, H. L. Stores Room Methods of the Pond Machine Tool Works (Illustrated) 919

Ashford, John Stores Arrangement as a Factor in Shop Management (Illustrated) 93, 177

Automobile Vehicles—Latest Types of Industrial (Illustrated) *Lucien Périssé* 897

Barr, Wm. M. A Development of Recent Machine-Shop Processes. The Production of Interchangeable Work in the General Shop 249

Barr, Wm. M. The Development of Power Pumping Machinery (Illustrated) 616

Bignami, Enrico The Mines and Mineral Industries of Italy (Illustrated) 199

Big Stone Gap Coalfield of Virginia and Kentucky (Illustrated) *John Leggett Pultz* 71

Boilers—Experiment and Practice in the Construction of Steam *Egbert P. Watson* 402

Brazil—Mining and Hydraulic Engineering in (Illustrated) *William Maude* 779

Brewer, William M. Smelters and Smelting Practice in British Columbia (Illustrated) 333

British Columbia—Smelters and Smelting Practice in (Illustrated) *William M. Brewer* 333

Bryan, William H. The St. Louis Exposition from the Standpoint of the Engineer (Illustrated) 1

Buel, A. W. Cost Keeping in Construction and Contract Work 971

Building of a Chinese Railway (Illustrated) *Justin Burns* 161, 380

Burns, Justin The Building of a Chinese Railway (Illustrated) 161, 380

Burr, Wm. H. The Present Aspects of the Panama Canal . 481

Canadian Niagara District—Hydro-Electric Power Plants in the (Illustrated) *Cecil B. Smith* 727

Canal Commission—Work of the Panama *C. E. Grunsky* . 804

Canal—The Present Aspects of the Panama *Wm. H. Burr* . 481

Canal—The Revival of De Lesseps' Sea-Level Plan for the Panama *Gen. Henry L. Abbot* 721

Care and Control of the Small-Tool Equipment in the Shop *R. Emerson* 793

Causes of Accidents on American Railways *F. W. Haskell* . 321

Cement Mill in the Pyrenees—A Gravity (Illustrated) Geo. *M. Peck* 369

Central Stations—Electric Power Supply in Great Britain (Illustrated) *G. L. Addenbrooke* 761

Chinese Railway—The Building of a (Illustrated) *Justin Burns* 161, 380

Coalfields of Virginia and Kentucky—The Big Stone Gap (Illustrated) *John Leggett Pultz* 71

Coal Mining—Labor-Saving Devices in (Illustrated) *R. V. Norris* 553

Coal—The Economy of Small-Size for the Power Plant *Percival Robert Moses* 753

Combinations—A Study of Steam Costs in Industrial *William D. Ennis* 86

Commission—Work on the Panama Canal *C. E. Grunsky* . 804

Compensation of Labor *H. L. Gantt* 881

Compound Locomotive in England—The Development of the (Illustrated) *W. E. Dalby* 35

Construction and Contract Work—Cost Keeping in *A. W. Buel* 971

Contract and Construction Work—Cost Keeping in *A. W. Buel* 971

Contract Work—Excavating and Conveying Machinery in (Illustrated) *C. H. Wright* 520

Control and Care of the Small-Tool Equipment in the Shop *R. Emerson* 793

Conveying Machinery in Contract Work—Excavating and (Illustrated) *C. H. Wright* 520

Cost Keeping in Construction and Contract Work *A. W. Buel* 971

Costs in Industrial Combinations—A Study of Steam *William D. Ennis* 86

Dalby, W. E. The Development of the Compound Locomotive in England (Illustrated) 35

Del Mar, Alexander Gold Mining in the Ancient Roman Workings in Spain 887

DEVELOPMENT OF DRY-DOCK PUMPING MACHINERY (Illustrated) *Joseph S. Shultz* 348
DEVELOPMENT OF ECONOMY IN RAILROAD TRANSPORTATION SINCE 1875 *S. Whinery* 653
DEVELOPMENT OF POWER MACHINERY (Illustrated) *Wm. M. Barr* 616
DEVELOPMENT OF RECENT MACHINE-SHOP PROCESSES. THE PRODUCTION OF INTERCHANGEABLE WORK IN THE GENERAL SHOP. *Wm. M. Barr* 249
DEVELOPMENT OF THE COMPOUND LOCOMOTIVE IN ENGLAND (Illustrated) *W. E. Dalby* 35
DISCUSSION OF METHODS OF UNDERGROUND TRANSPORTATION (Illustrated) *John Bonsall Porter* 625
DOCK PUMPING MACHINERY—THE DEVELOPMENT OF DRY (Illustrated) *Joseph S. Shultz* 348
DRY-DOCK PUMPING MACHINERY—THE DEVELOPMENT OF (Illustrated) *Joseph S. Shultz* 348
ECONOMY—INFLUENCE OF SUPERHEATED STEAM ON ENGINE (Illustrated) *R. Neilson* 942
ECONOMY IN RAILROAD TRANSPORTATION SINCE 1875—THE DEVELOPMENT OF *S. Whinery* 653
ECONOMY OF SMALL-SIZE COAL FOR THE POWER PLANT *Percival Robert Moses* 753
ELECTRIC INTERURBAN SYSTEMS FOR FREIGHT AND PASSENGERS—HIGH-SPEED (Illustrated) *Ralph Scott* 56
ELECTRIC POWER FOR MINE WORK *F. V. Henshaw* . . . 965
ELECTRIC POWER SUPPLY FROM CENTRAL STATIONS IN GREAT BRITAIN (Illustrated) *G. L. Addenbrooke* 761
ELEVATOR TYPES AND ELEVATOR PRACTICE—MODERN *Howard S. Knowlton* 241
Emerson, R. CARE AND CONTROL OF THE SMALL-TOOL EQUIPMENT IN THE SHOP 793
Emerson, R. SYSTEMATIZATION AND TOOL-ROOM PRACTICE IN A RAILWAY REPAIR SHOP 411
ENGINE ECONOMY—INFLUENCE OF SUPERHEATED STEAM ON (Illustrated) *R. Neilson* 942
ENGINES—THE TESTING OF STEAM (Illustrated) *Capt. H. Riall Sankey and C. Humphrey Wingfield* 220
ENGLAND—THE DEVELOPMENT OF THE COMPOUND LOCOMOTIVE IN (Illustrated) *W. E. Dalby* 35
Ennis, William D. A STUDY OF STEAM COSTS IN INDUSTRIAL COMBINATIONS 86
EXCAVATING AND CONVEYING IN CONTRACT WORK (Illustrated) *C. H. Wright* 520
EXPERIMENT AND PRACTICE IN THE CONSTRUCTION OF STEAM BOILERS *Egbert P. Watson* 402

EXPOSITION FROM THE STANDPOINT OF THE ENGINEER—THE ST. LOUIS (Illustrated) *William H. Bryan* 1

FACTORY—HOW TO INTRODUCE HIGH-SPEED STEEL INTO A (Illustrated) *A. D. Wilt, Jr.* 49

Gantt, H. L. THE COMPENSATION OF LABOR 881

GOLD MINING IN THE ANCIENT ROMAN WORKINGS IN SPAIN *Alexander Del Mar* 887

GRAVITY CEMENT MILL IN THE PYRENEES (Illustrated) *Geo. M. Peek* 369

GREAT BRITAIN—ELECTRIC POWER SUPPLY FROM CENTRAL STATIONS (Illustrated) *G. L. Addenbrooke* 761

Grunsky, C. E. THE WORK OF THE COMMISSION ON THE PANAMA CANAL 804

HANDLING IN THE MANUFACTURE OF IRON AND STEEL—MECHANICAL (Illustrated) *James N. Hatch* 591

HANDLING OF MATERIALS—LABOR SAVING IN THE (Illustrated) *Arch. J. S. B. Little* 570

Haskell, F. W. THE CAUSES OF ACCIDENTS ON AMERICAN RAILWAYS 321

Hatch, James N. MECHANICAL HANDLING IN THE MANUFACTURE OF IRON AND STEEL (Illustrated) 591

Henshaw, F. V. USE OF ELECTRIC POWER FOR MINE WORK . . 965

HIGH-SPEED ELECTRIC INTERURBAN SYSTEMS FOR FREIGHT AND PASSENGERS (Illustrated) *Ralph Scott* 56

HIGH-SPEED STEEL INTO A FACTORY—HOW TO INTRODUCE (Illustrated) *A. D. Wilt, Jr.* 49

HOW TO INTRODUCE HIGH-SPEED STEEL INTO A FACTORY (Illustrated) *A. D. Wilt, Jr.* 49

HYDRAULIC AND MINING ENGINEERING IN BRAZIL (Illustrated) *William Maude* 779

HYDRO-ELECTRIC POWER PLANTS IN THE CANADIAN NIAGARA DISTRICT (Illustrated) *Cecil B. Smith* 727

INDUSTRIAL AUTOMOBILE VEHICLES—LATEST TYPES OF (Illustrated) *Lucien Périssé* 897

INDUSTRIAL COMBINATIONS—A STUDY OF STEAM COSTS IN *William D. Ennis* 86

INTERCHANGEABLE WORK IN THE GENERAL SHOP—THE PRODUCTION OF *Wm. M. Barr* 249

INTERURBAN SYSTEMS FOR FREIGHT AND PASSENGERS—HIGH-SPEED ELECTRIC (Illustrated) *Ralph Scott* 56

IRON AND STEEL—MECHANICAL HANDLING IN THE MANUFACTURE OF (Illustrated) *James N. Hatch* 591

ITALY—THE MINES AND MINERAL INDUSTRIES OF (Illustrated) *Enrico Bignami* 199

Knowlton, Howard S. MODERN ELEVATOR TYPES AND ELEVATOR PRACTICE 241

LABOR—COMPENSATION OF *H. L. Gantt* 881

LABOR-SAVING DEVICES IN COAL MINING (Illustrated) *R. V. Norris* 553

LABOR SAVING IN THE HANDLING OF MATERIALS (Illustrated) *Arch. J. S. B. Little* 570

LATEST TYPES OF INDUSTRIAL AUTOMOBILE VEHICLES (Illustrated) *Lucien Pèrissè* 897

Little, Arch. J. S. B. LABOR SAVING IN THE HANDLING OF MATERIALS (Illustrated) 570

LOCOMOTIVE IN ENGLAND—THE DEVELOPMENT OF THE COMPOUND (Illustrated) *W. E. Dalby* 35

MACHINE SHOP—MECHANICAL TRANSPORTATION IN THE MODERN (Illustrated) *Frederick A. Waldron* 489

MACHINE-SHOP PROCESSES—A DEVELOPMENT OF RECENT. THE PRODUCTION OF INTERCHANGEABLE WORK IN THE GENERAL SHOP. *William M. Barr* 249

MACHINE TOOL WORKS—STORES ROOM METHODS OF THE POND (Illustrated) *H. L. Arnold* 919

MANAGEMENT—STORES ARRANGEMENT AS A FACTOR IN (Illustrated) *John Ashford* 93, 177

MANUFACTURE OF IRON AND STEEL—MECHANICAL HANDLING IN THE (Illustrated) *James N. Hatch* 591

MATERIALS—LABOR SAVING IN THE HANDLING OF (Illustrated) *Arch. J. S. B. Little* 570

Maude, William MINING AND HYDRAULIC ENGINEERING IN BRAZIL (Illustrated) 779

MECHANICAL HANDLING IN THE MANUFACTURE OF IRON AND STEEL (Illustrated) *James N. Hatch* 591

MECHANICAL TRANSPORTATION IN THE MODERN MACHINE SHOP (Illustrated) *Frederick A. Waldron* 489

MECHANICAL TRANSPORT OF AIR (Illustrated) *Walter B. Snow* . 541

MINE—POWER GENERATION AND TRANSMISSION FOR A MODERN (Illustrated) *E. H. Roberton* 644

MINES AND MINERAL INDUSTRIES OF ITALY (Illustrated) *Enrico Bignami* 199

MINE WORK—ELECTRIC POWER FOR *F. V. Henshaw* . . . 965

MINING AND HYDRAULIC ENGINEERING IN BRAZIL (Illustrated) *William Maude* 779

MINING—GOLD, IN THE ANCIENT ROMAN WORKINGS IN SPAIN *Alexander Del Mar* 887

MINING—LABOR-SAVING DEVICES IN COAL (Illustrated) *R. V. Norris* 553

MODERN ELEVATOR TYPES AND ELEVATOR PRACTICE *Howard S. Knowlton* 241

Moses, Percival Robert THE ECONOMY OF SMALL-SIZED COAL FOR THE POWER PLANT 753

Neilson, R. SUPERHEATING STEAM AND ITS INFLUENCE ON ENGINE ECONOMY 942

Niagara—Hydro-Electric Plants in the Canadian District (Illustrated) *Cecil B. Smith* 727

Norris, R. V. Labor-Saving Devices in Coal Mining (Illustrated) 553

Obsolete Methods and Current Practice in Shop Administration. *Egbert P. Watson* 211

Panama Canal Commission—Work of the *C. E. Grunsky* 804

Panama Canal—The Present Aspects of the *Wm. H. Burr* 481

Panama Canal—The Revival of De Lesseps' Sea-Level Plan for *Gen. Henry L. Abbot* 721

Peek, Geo. M. A Gravity Cement Mill in the Pyrenees (Illustrated) 369

Périssé, Lucien Latest Types of Industrial Automobile Vehicles (Illustrated) 897

Pond Machine Tool Works—Stores Room Methods of (Illustrated). *H. L. Arnold* 919

Porter, John Bonsall A Discussion of Methods of Underground Transportation (Illustrated) 625

Power Generation for a Modern Mine (Illustrated) *E. H. Roberton* 644

Power Plant—The Economy of Small Size Coal for *Percival Robert Moses* 753

Power Plants—Hydro-Electric, in the Canadian Niagara District (Illustrated) *Cecil B. Smith* 727

Power Pumping Machinery—The Development of (Illustrated) *Wm. M. Barr* 616

Present Aspect of the Panama Canal *Wm. H. Burr* 481

Pultz, John Leggett The Big Stone Gap Coalfield of Virginia and Kentucky (Illustrated) 71

Pumping Machinery—The Development of Dry-Dock (Illustrated) *Joseph S. Shultz* 348

Pumping Machinery—The Development of Power (Illustrated) *Wm. M. Barr* 616

Pyrenees—A Gravity Cement Mill in the (Illustrated) *Geo. M. Peek* 369

Railroad Transportation Since 1875—The Development of Economy in *S. Whinery* 653

Railway Repair Shop Systematization and Tool-Room Practice in a *R. Emerson* 411

Railways for Freight and Passengers—High-Speed Electric (Illustrated) *Ralph Scott* 56

Railways—The Causes of Accidents on American *F. W. Haskell* 321

Railway—The Building of a Chinese (Illustrated) *Justin Burns* 161, 380

Repair Shop—Systematization and Tool-Room Practice in a Railway *R. Emerson* 411

REVIVAL OF DE LESSEPS' SEA-LEVEL PLAN FOR THE PANAMA CANAL *Gen. Henry L. Abbot* 721
Roberton, E. H. POWER GENERATION AND TRANSMISSION FOR A MODERN MINE (Illustrated) 644
ST. LOUIS EXPOSITION FROM THE STANDPOINT OF THE ENGINEER (Illustrated) *William H. Bryan* 1
Sankey, Capt. H. Riall, and C. Humphrey Wingfield THE TESTING OF STEAM ENGINES (Illustrated) 220
Scott, Ralph HIGH-SPEED ELECTRIC INTERURBAN SYSTEMS FOR FREIGHT AND PASSENGERS (Illustrated) 56
SHOP ADMINISTRATION—OBSOLETE METHODS AND CURRENT PRACTICE IN *Egbert P. Watson* 211
SHOP—CARE AND CONTROL OF THE SMALL-TOOL EQUIPMENT IN THE *R. Emerson* 793
SHOP MANAGEMENT—STORES ARRANGEMENT AS A FACTOR IN (Illustrated) *John Ashford* 93, 177
SHOP PROCESSES—A DEVELOPMENT OF RECENT MACHINE. THE PRODUCTION OF INTERCHANGEABLE WORK IN THE GENERAL SHOP. *Wm. M. Barr* 249
SHOP—SYSTEMATIZATION AND TOOL-ROOM PRACTICE IN A RAILWAY REPAIR *R. Emerson* 411
Shultz, Joseph S. THE DEVELOPMENT OF DRY-DOCK PUMPING MACHINERY (Illustrated) 348
SMALL-SIZE COAL—THE ECONOMY FOR THE POWER PLANT *Percival Robert Moses* 753
SMALL-TOOL EQUIPMENT IN THE SHOP—CONTROL AND CARE OF *R. Emerson* 793
SMELTERS AND SMELTING PRACTICE IN BRITISH COLUMBIA (Illustrated) *William M. Brewer* 333
Smith, Cecil B. HYDRO-ELECTRIC POWER PLANTS IN THE CANADIAN NIAGARA DISTRICT (Illustrated) 727
Snow, Walter B. THE MECHANICAL TRANSPORT OF AIR (Illustrated) 541
SPAIN—GOLD MINING IN THE ANCIENT ROMAN WORKINGS IN *Alexander Del Mar* 887
STEAM BOILERS—EXPERIMENT AND PRACTICE IN THE CONSTRUCTION OF *Egbert P. Watson* 402
STEAM COSTS IN INDUSTRIAL COMBINATIONS—A STUDY OF *William D. Ennis* 86
STEAM ENGINES—THE TESTING OF (Illustrated) *Capt. H. Riall Sankey and C. Humphrey Wingfield* 220
STEAM—SUPERHEATING OF, AND ITS INFLUENCE ON ENGINE ECONOMY (Illustrated) *R. Neilson* 942
STEEL INTO A FACTORY—HOW TO INTRODUCE HIGH-SPEED (Illustrated) *A. D. Wilt, Jr.* 49
STEEL—MECHANICAL HANDLING IN THE MANUFACTURE OF IRON AND (Illustrated) *James N. Hatch* 591

STORES ARRANGEMENT AS A FACTOR IN SHOP MANAGEMENT (Illustrated) *John Ashford* 93

STORES ARRANGEMENT AS A FACTOR IN SHOP MANAGEMENT. II. (Illustrated) *John Ashford* 177

STORES ROOM METHODS OF THE POND MACHINE TOOL WORKS (Illustrated) *H. L. Arnold* 919

STUDY OF STEAM COSTS IN INDUSTRIAL COMBINATIONS *William D. Ennis* 86

SUPERHEATING OF STEAM AND ITS INFLUENCE ON ENGINE ECONOMY (Illustrated) *R. Neilson* 942

SYSTEMATIZATION AND TOOL-ROOM PRACTICE IN A RAILWAY SHOP *R. Emerson* 411

TESTING OF STEAM ENGINES (Illustrated) *Capt. H. Riall Sankey and C. Humphrey Wingfield* 220

TOOL EQUIPMENT—CARE AND CONTROL OF SMALL, IN THE SHOP *R. Emerson* 793

TOOL-ROOM PRACTICE IN A RAILWAY REPAIR SHOP *R. Emerson* . 411

TRANSMISSION FOR A MODERN MINE—POWER GENERATION (Illustrated) *E. H. Roberton* 644

TRANSPORTATION—A DISCUSSION OF METHODS OF UNDERGROUND (Illustrated) *John Bonsall Porter* 625

TRANSPORTATION IN THE MODERN MACHINE SHOP—MECHANICAL (Illustrated) *Frederick A. Waldron* 489

TRANSPORTATION SINCE 1875—THE DEVELOPMENT OF ECONOMY IN RAILROAD *S. Whinery* 653

TRANSPORT OF AIR—THE MECHANICAL (Illustrated) *Walter B. Snow* 541

UNDERGROUND TRANSPORTATION—A DISCUSSION OF METHODS OF (Illustrated) *John Bonsall Porter* 625

USE OF ELECTRIC POWER FOR MINE WORK. *F. V. Henshaw* . . 965

VEHICLES—LATEST TYPES OF INDUSTRIAL AUTOMOBILE (Illustrated) *Lucien Périssé* 897

Waldron, Frederick A. MECHANICAL TRANSPORTATION IN THE MODERN MACHINE SHOP (Illustrated) 489

Watson, Egbert P. EXPERIMENT AND PRACTICE IN THE CONSTRUCTION OF STEAM BOILERS 402

Watson, Egbert P. OBSOLETE METHODS AND CURRENT PRACTICE IN SHOP ADMINISTRATION 211

Whinery, S. THE DEVELOPMENT OF ECONOMY IN RAILROAD TRANSPORTATION SINCE 1875 653

Wilt, A. D., Jr. HOW TO INTRODUCE HIGH-SPEED STEEL INTO A FACTORY (Illustrated) 49

Wingfield, C. Humphrey, and Capt. H. Riall Sankey THE TESTING OF STEAM ENGINES (Illustrated) 220

WORK OF THE COMMISSION ON THE PANAMA CANAL *C. E. Grunsky* 804

Wright, C. H. EXCAVATING AND CONVEYING MACHINERY IN CONTRACT WORK (Illustrated) 520

REVIEWS, INDEX, AND EDITORIALS.

Accidents—Railroad, in America 833
Accidents—Railway, in England and America 981
Alloys—Special Nickel Steel 823
Alloy Steels—Ternary 443
Alpine Railway Building 684
America and England—Railway Accidents in 981
American Coals—Testing of 841
America—Railroad Accidents in 833
Arches—Modern Masonry 429
Artificial Ventilation on Shipboard 433
Baikalien Railway—Circum 682
Balloons—Dirigible 113
Behavior of Steel under Vibration 123
Blast-Furnace Practice — Improvements in 427
Boats—High-Speed Motor 838
Boiler Design—Water-Tube 671
Boiler Feed Waters—Air in 259
Boilers—Naval 109
Book Received 480
Book Reviews 160, 447
Buildings—The Fire Resistance of Modern High 268
Canal Lifts, Mechanical 991
Castings—The Manufacture of Steel 107
Cast Iron—Economic Value of 985
Cement—The Constitution of Portland 121
Chemistry in the Foundry 681
Chrome-Vanadium Steel 840
Circum—Baikalien Railway 682
Civil Engineering, Engineering Index 125, 281, 445, 687, 843, 1003
Coals—Testing of American 841
Concrete—Strength of 988
Condensing Machinery 835
Constitution of Portland Cement 121
Continuous Currents — Long-Distance Transmissions with 423
Cost of Production 663
Current Record of New Books 160, 477
Currents—Long-Distance Transmissions with Continuous 423
Destructor Stations—Refuse 1000
Development of Invention 115
Development of the Electric Locomotive 821
Development of the Forging Press 267
Diagrams—Magnetic Flux 823
Dirigible Balloons 113
Economic Value of Cast Iron 985
Editorial Comment. 101, 255, 418, 661, 815, 979
Education—Problems of Engineering. 265
Efficiency of the Gas Turbine 273
Electrical Energy—The Transmission of 257
Electrical Engineering, Engineering Index 132, 286, 450, 693, 848
Electric Locomotive—Development of the 821
Electric Locomotive Traction 679
Electric Railway—The Mont Blanc 276
Electric Traction—Local Railway 829
Electric Traction for Railways 271
Electric Traction—Main Line 983
Electric Traction—Single-Phase 119
Electric Traction—Water Power for. 998
Engineering Education—Problems of. 265
Engineering Index 125, 281, 445, 687, 843, 1003
Engineering in the Foundry 277
Engineer—The Equipment of the 685
Engines—Gas, Oil and Steam 430
Engines—Steam Turbines and Reciprocating 669
England and America—Railway Accidents in 981
Equipment of the Engineer 685
Feed Waters—Air in Boiler 259
Fire Resistance of Modern High Buildings 268
Flux Diagrams—Magnetic 825
Forging Press—The Development of. 267
Foundry—Chemistry in the 681
Foundry—Engineering in the 277
Fuel for Marine Service—Liquid 261
Furnace Practice—Improvements in Blast 427
Glacier Protection Works 832
Gas Engines—Methods of Testing 279
Gas, Oil and Steam Engines 430
Gas Turbine 438
Gas Turbine—The Efficiency of the 273
Great Britain—Hydraulic Power in 819
High Buildings—The Fire Resistance of Modern 268
High-Speed Motor Boats 838
Hoisting Problems in Mining 993
Hydraulic Lift Locks 117
Hydraulic Mains—Strength of 1001
Hydraulic Power in Great Britain 819
Impact Tests on Steel 677
Improvements in Blast-Furnace Practice 427
Index—The Engineering 125, 281, 445, 687, 843, 1003
Industrial Economy, Engineering Index 138, 296, 454, 697, 854, 1016
Internal Transport in the United States 434
Invention—The Development of 115
Iron—Economic Value of Cast 985
Lift Locks—Hydraulic 117
Lifts—Mechanical Canal 991
Line Engineering—Telephone 989
Liquid Fuel for Marine Service 261
Local Electric Railway Traction 829
Locks—Hydraulic Lift 117
Locomotive—Development of the 821
Locomotive Traction—Electric 679
Long-Distance Power Transmission 830
Long Distance Transmissions with Continuous Currents 423
Machinery—Condensing 835
Machine Tools—Motor-Driven 421
Magnetic Flux Diagrams 825
Main Line Electric Traction 983
Mains—Strength of Hydraulic 1001

Manufacture of Steel Castings....... 107
Manufacturing—Technology and..... 111
Marine and Naval Engineering, Engineering Index. 138, 298, 455, 698, 855, 1017
Marine Service—Liquid Fuel for..... 261
Masonry Arches—Modern............ 429
Materials—Modern Methods of Testing 441
Materials—Shop Testing of.......... 995
Matter—The New Theory of......... 103
Mechanical Canal Lifts................ 991
Mechanical Engineering, Engineering Index........140, 299, 456, 701, 856, 1018
Mechanical Science—Some Refinements of.......................... 665
Metallurgical Slags.................. 667
Methods of Testing Gas Engines.... 279
Mines—Respiration Devices for...... 263
Mining and Metallurgy, Engineering Index.......147, 307, 464, 708, 865, 1026
Mining—Hoisting Problems in....... 993
Modern Masonry Arches............ 429
Modern Methods of Testing Materials 441
Modern War-Ship Design........... 675
Mont Blanc Electric Railway........ 276
Motor Boats—High Speed........... 838
Motor-Driven Machine Tools......... 421
Naval Boilers...................... 109
New Theory of Matter.............. 103
Nickel-Steel Alloys—Special.......... 823
Oil and Steam Engines—Gas......... 430
Point of View..................... 440
Portland Cement—The Constitution of 121
Power-Plant Engineering—Steam 274
Power-Transmission—Long Distance. 830
Present Problems in Technology.... 105
Press—The Development of the Forging 267
Problems in Mining Hoisting....... 993
Problems of Engineering Education... 265
Problems in Technology—Present... 105
Production—The Cost of............ 665
Protection Works—Glacier........... 832
Punching as a Method of Testing.... 995
Railroad Accidents in America....... 833
Railway Accidents in England and America 981
Railway Building—Alpine........... 684
Railway—Circum-Baikalien 682
Railway Engineering, Engineering Index.........152, 312, 469, 713, 870, 1032
Railways—Electric Traction for...... 271
Railway—The Mont Blanc Electric... 276
Rapid Tool Steels.................. 425
Reciprocating Engines—Steam Turbines and.......................... 669
Refinements of Mechanical Science—Some 665
Refuse Destructor Stations.......... 1000
Respiration Devices for Mines........ 263
Science—Some Refinements of Mechanical 665
Shipboard—Artificial Ventilation on.. 433
Shop Testing of Materials.......... 995
Single-Phase Electric Traction....... 119
Slags—Metallurgical 667
Some Refinements of Mechanical Science 665
Special Nickel-Steel Alloys.......... 823
Speed Indicators—Vibratory......... 673
Speed of Steam Vessels............. 436
Stations—Refuse Destructor 1000
Steam Engines—Gas, Oil and........ 430
Steam Power-Plant Engineering...... 274
Steam Turbines and Reciprocating Engines 669
Steam Vessels—The Speed of........ 436
Steel Castings—The Manufacture of.. 107
Steel—Chrome-Vanadium 840
Steel—Impact Tests on.............. 677
Steels—Rapid Tool.................. 425
Steels—Ternary Alloy.............. 443
Steel under Vibration, The Behavior of 123
Street and Electric Railways, Engineering Index...156, 316, 472, 716, 873, 1035
Strength of Concrete............... 988
Strength of Hydraulic Mains........ 1001
Technology and Manufacturing...... 111
Technology—Present Problems in... 105
Telephone Line Engineering......... 989
Ternary Alloy Steels............... 443
Testing Gas Engines—Methods of... 279
Testing Materials—Modern Methods of 441
Testing of American Coals.......... 841
Testing of Materials—Shop......... 995
Tests on Steel—Impact............. 677
Theory of Matter—The New......... 103
Tidal Power—Utilization of......... 997
Tools—Motor-Driven Machine....... 421
Tool Steels—Rapid................. 425
Traction—Electric Locomotive....... 679
Traction—Local Electric Railway.... 829
Traction—Main-Line Electric........ 983
Traction—Single-Phase Electric...... 119
Traction—Water Power for Electric. 998
Transmission—Long-Distance Power. 830
Transmission of Electrical Energy... 257
Transmissions with Continuous Currents—Long-Distance 423
Transport in the United States—Internal 434
Turbines and Reciprocating Engines—Steam 669
Turbine—The Efficiency of the Gas... 273
Turbine—The Gas.................. 438
United States—Internal Transport in the 434
Utilisation of Tidal Power.......... 997
Vanadium-Chrome Steel............ 840
Ventilation on Shipboard—Artificial.. 433
Vessels—The Speed of Steam....... 436
Vibration—The Behavior of Steel under 123
Vibratory Speed Indicators.......... 673
View—The Point of................ 440
War-Ship Design—Modern.......... 675
Water Power for Electric Traction.. 998
Waters—Air in Boiler Feed.......... 259
Water-Tube Boiler Design........... 671
Works—Glacier Protection.......... 832

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THE ST. LOUIS EXPOSITION, FROM THE STANDPOINT OF THE ENGINEER.

By William H. Bryan.

Mr. Bryan considers the St. Louis Exposition—what it is, and what it exhibits—as a current record and demonstration of engineering progress. It is most interesting to compare it from this point of view with the still recent Buffalo Exposition, which was reviewed in these pages in October, 1901, and to note the advance, especially in power generation and electric applications.—THE EDITORS.

"EXPOSITIONS are the time keepers of progress." Thus spoke President McKinley in his memorable address at the Buffalo exposition. Every engineer in touch with industrial development will bear eloquent testimony to this truth.

On April 30, 1803, a treaty was signed between France and the United States by which the latter acquired, for the consideration of $15,000,000, the territory west of the Mississippi River (then known as Louisiana) aggregating 1,171,931 square miles—an addition which more than doubled the national domain.

A popular movement looking to the celebration of the centennial of the event began in St. Louis in 1898. In January, 1899, a congress representing the fourteen States and territories which had been carved out of the Louisiana Purchase, met in St. Louis and formally launched the project of a universal exposition. It was early determined that the event justified a celebration which would excel all previous efforts. An executive and a general committee of two hundred citizens was formed, and Congress shortly afterward gave the enterprise formal approval. President McKinley then issued a proclamation inviting the participation of all nations. A special charter

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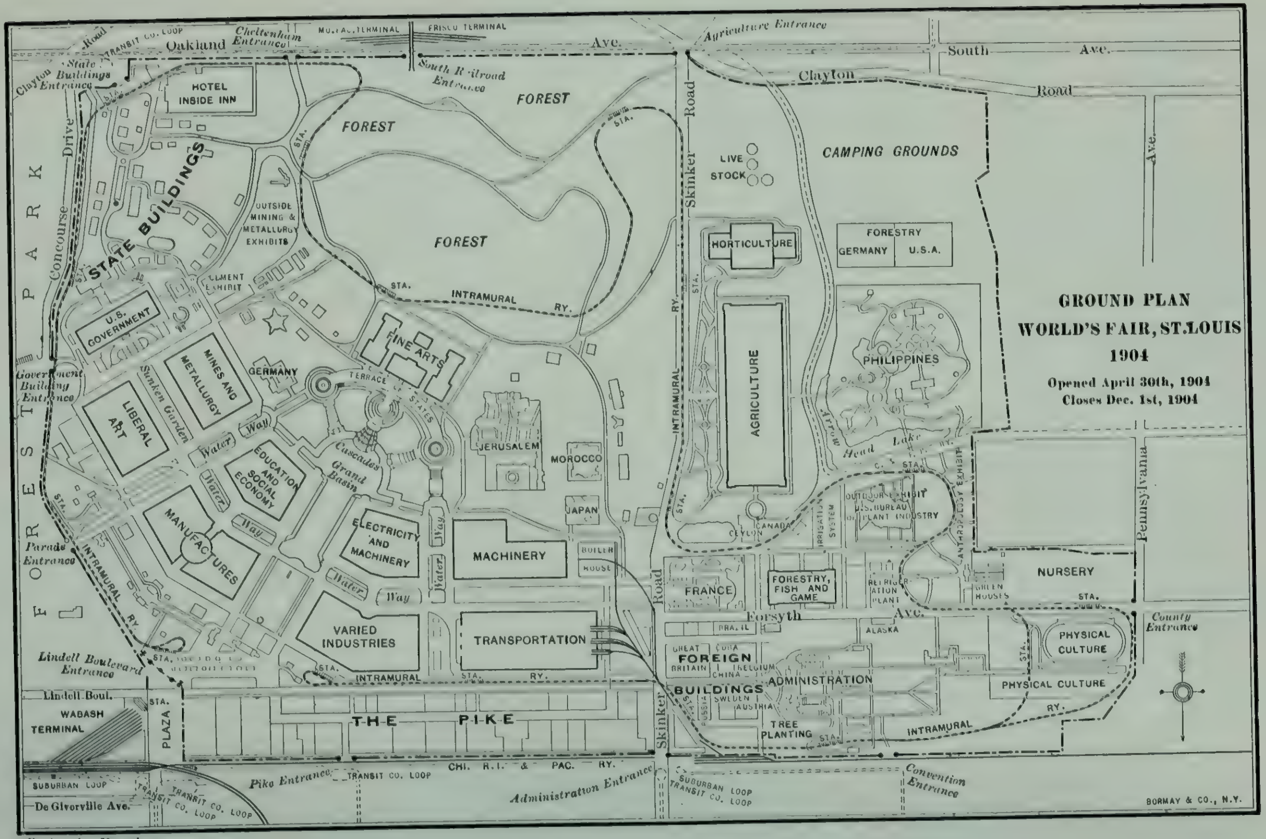


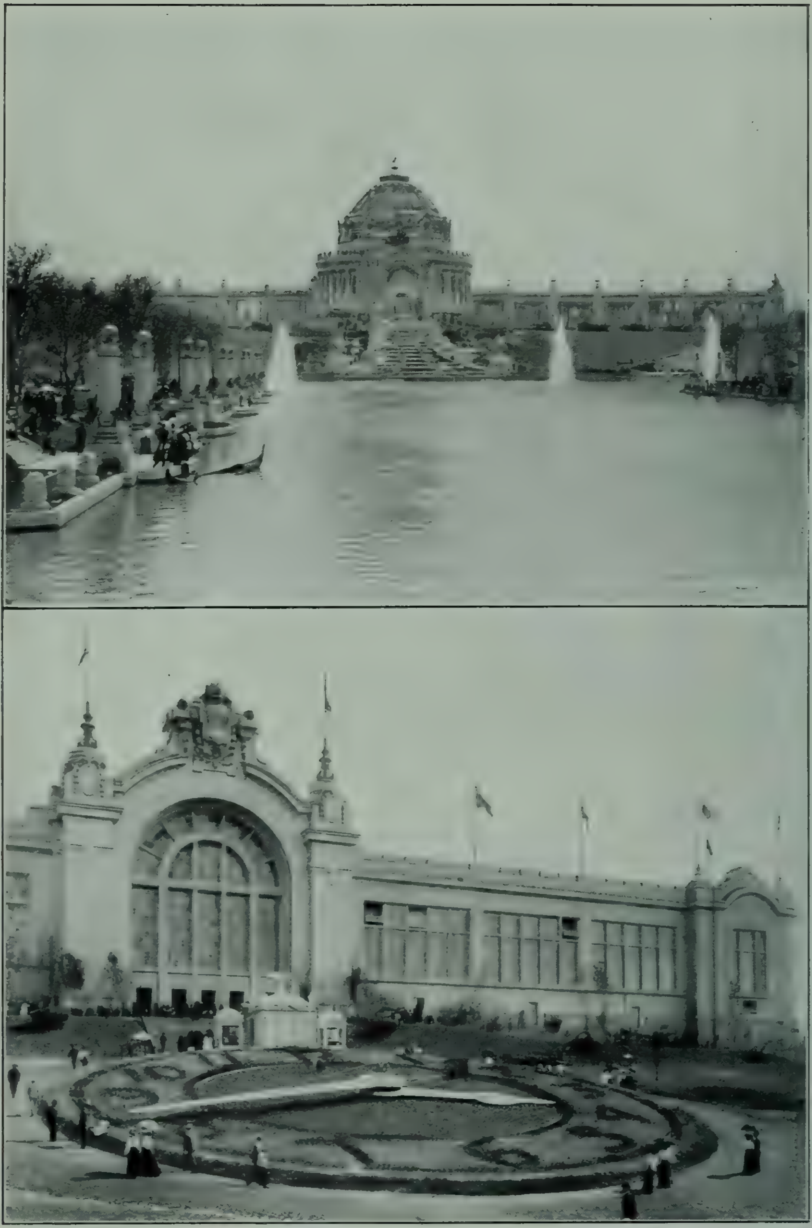
Engineering Magazine

GENERAL OUTLINE PLAN OF THE LOUISIANA PURCHASE EXPOSITION.

granted by the Missouri legislature authorized the incorporation of the Louisiana Purchase Exposition Co., with liberal powers and privileges. The selection of the old French city of St. Louis as a site was particularly fortunate. Not only is it the largest city in the territory, but there is said to be a larger population within a radius of 500 miles than in any similar circle in America. The progressiveness of the city, the hospitality of its people, the extent of its manufactures, its proximity to the great southern Illinois coal-fields, its importance as a railway center, and its location on the great Mississippi River, near the mouths of the Missouri and Illinois, are all factors in its commercial importance.

Finances were, of course, of first importance, and stock subscriptions were invited, resulting in the underwriting of the entire amount, $5,000,000, payable in installments. These came from railroads, business houses, hotels, and public-spirited citizens of high and low degree. By popular vote the city of St. Louis issued $5,000,000 in bonds. The United States Government gave $5,000,000, adding later a loan of $4,600,000. The cost of its own exhibits, including the Government and Fisheries buildings, and the Philippines, life-savers, soldiery, etc., reached nearly as much more. The State of Missouri appropriated $1,000,000, other States and territories $6,000,000, foreign Governments $5,000,000. A conservative estimate of the total which has been spent to bring about the present splendid result is $50,000,000. Never before has so large a sum been available for such a purpose, nor is it likely to be again.

The question of site presented many complications, the requirements being ample area, accessibility, favorable topography, and reasonable cost. Many favored the banks of the historic Mississippi River, but insurmountable difficulties developed in that direction. The solution came when the city of St. Louis tendered the western half of Forest Park, then an unimproved wilderness of rolling topography, covered mostly by a dense forest of old oak trees. The eastern and improved section of this park is one of the city's most popular outing grounds. The distance from the heart of the city to the Fair's eastern boundary line is 5½ miles. Although the 700 acres thus secured exceeded the area of any previous exposition, it was deemed insufficient, and extensive tracts to the north and west were leased. Included in this territory is the 100-acre campus of Washington University, and its six new permanent granite buildings. These leases extended the western boundary a considerable distance beyond the western city limits, and completed the Exposition territory (page 2)



THE CASCADES, FROM THE GRAND BASIN, SOMETIMES CALLED THE "MAIN PICTURE" OF THE EXPOSITION, AND THE FLORAL CLOCK IN FRONT OF THE PALACE OF AGRICULTURE.

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which is now approximately two miles long east-and-west by one mile wide, and aggregates 1,240 acres, double the area devoted to the largest previous exposition, the Columbian.

The Exposition authorities seem, however, to have over-estimated their requirements, for it has been found impossible to utilize to advantage this vast area. Ample grounds permitted buildings of great area, extensive waterways, opportunities for landscape gardening, and agricultural, horticultural, and forestry exhibits; splendid avenues, vistas, and plazas; and room for immense special exhibits. But it involved serious problems of inter-communication, roadways, preparation and care of grounds, water service, drainage, and has led to great discomfort to the visitor in attempting to cover such long distances. Much of the enclosure is unimproved and practically unoccupied; parts are wholly neglected, and others used for storage of débris of every sort, detracting not a little from the finished picture. The general effect would have been better if the work had been concentrated within, say, two-thirds the present area.

Transportation to the grounds has been well worked out. Seven branches of the St. Louis Transit Company's lines, and three of the Suburban system—both surface electric—reach the grounds, covering the distance from the heart of the city in about 35 minutes. Shuttle trains run between the Union Station and the main entrance at 15-minute intervals, making the run in about 12 minutes. There is also an automobile service from down town. Inside the Exposition the Intramural, a double-track surface electric-trolley line, on the multiple-unit system, skirts the grounds. Its length of double track is 7 miles, and about 30 minutes are required for the trip one way. The cars unfortunately are not well suited for observation purposes, being the ordinary closed box type with end entrances. The standard open car with side entrances would have been better. Automobiles traverse the principal avenues, and there are roller chairs, jinrickshas, and a miniature railway. These, with the launches, afford ample means for getting about.

At an early day a number of standing committees were appointed, each to look after a particular part of the work. A commission of ten leading architects was selected to prepare a general scheme of grounds and buildings. Five of these were from St. Louis, and five from other important cities, one of the latter, however, declining the appointment. This commission made a study of the topography of the site, and decided upon a general scheme for the main building, waterways, etc., mapping out what has since been so successfully executed as the "Main Picture."

PERMANENT BUILDINGS OF THE LOUISIANA PURCHASE EXPOSITION.

Forming part of the Washington University group. At the bottom is the Administration Building, being Brooking's Hall of the permanent University structures. Next above is the Anthropology Building—Cupples Hall No. 1 of the University, to be devoted to civil engineering and architecture. At the top is another of the Administration buildings—Cupples Hall No. 2, of the University group, to be used by the departments of mechanical and electrical engineering.

Unfortunately, the original scope of the commission of architects was not adhered to, the chairman personally assuming the supervision and control of all work, the commission itself never being called together after the first few meetings. This chairman, a man of much force of character and executive ability, overloaded himself in assuming the responsibility not only for the general architectural effect, but for all structural details—including engineering work—with results that from some standpoints are regrettable. Some of these would undoubtedly have been avoided had the ability and services of the original commission been retained. As the architectural features have already been amply discussed by competent critics, only two will be mentioned here. The first is the absence of monumental architectural closures at the outer ends of the three main courts. There is no effective ending to the view, the composition being left unfinished. The second is the absence of anything approaching the monumental—or even the dignified—at the main approaches or entrances.

The preparation of the grounds involved some difficult engineering. Through the site wandered the erratic River Des Pères, ordinarily harmless, but frequently overflowing its banks after severe rain storms. This stream had to be regulated, and its flow area enlarged. It has been enclosed in a wooden box, wholly concealed, its top covered with an asphalt roadway, now forming one of the main avenues. The irregularities of the site called for enormous amounts of grading and of pile driving to support some of the main buildings and machinery. A considerable portion of the area now occupied by the main picture was a deep forest, which formed one of its most picturesque attractions. The trees were felled with a ruthless hand, a step which brought so forcible a protest from the public as to cause a radical change in practice, too late, however, to save the best of them.

Not the least of the problems was the construction of roadways, for both the construction and Exposition periods. For the main thoroughfares asphaltum was employed, and brick on those of less importance. These have proven satisfactory, but the macadam and burnt clay used for the extensive system of ordinary roadways have given results less pleasing, being always in bad condition after heavy rains.

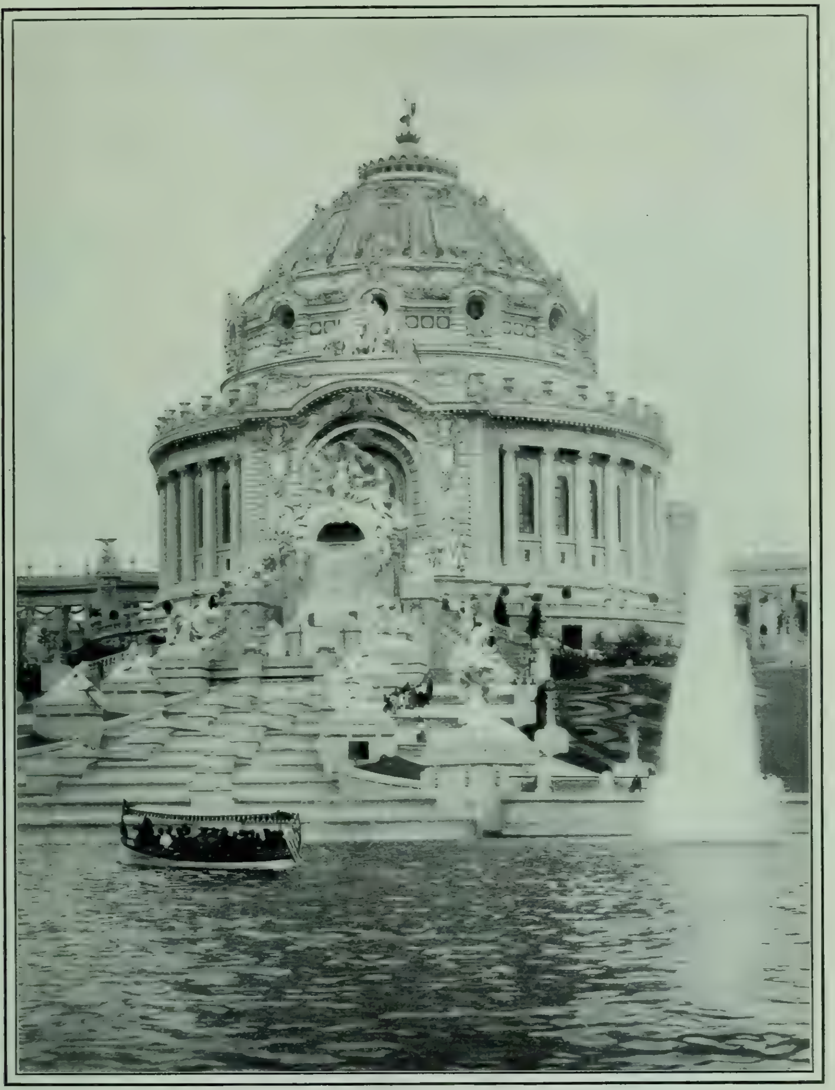
The drainage has been handled satisfactorily, the storm water going to the Des Pères, and the sewage proper by gravity to receiving tanks near the north corner of the Mines and Metallurgy Building, from which electric pumps lift it twenty feet and discharge it north to one of the main city sewers.

Water is supplied directly from the city system, at a special rate of one per cent. per 1,000 gallons. Individual filters for special uses are located at various points, one plant supplying the water to make up the leakage and evaporation from the lagoons. For ordinary use the supply is under city pressure, but the reserve in Arrowhead Lake is available for fire service. An independent system for fire protection has been laid, on which 150-pounds pressure is maintained by fourteen underwriters fire pumps of the horizontal duplex pattern, each automatically controlled. These are located in the northern portion of the Steam, Gas, and Fuels Building.

The design and grouping of the principal buildings in the "main picture" are extremely gratifying to the layman, although experts criticize some of the details. The interesting engineering feature is the extensive use of wood for the framing. Considerations of time and expense indicated originally that it would be inadvisable to use steel. Experts differ as to the wisdom of this conclusion, some holding that steel frame work could have been secured in ample time, and at but little if any greater cost. But three buildings, the United States and the Belgian National Pavilions, and the Steam, Gas, and Fuels Building, have steel frames. Everywhere else the construction is of wood, but on so gigantic a scale and involving such difficult problems as to excite wonder and admiration. The increased frequency of columns, however, the absence of spacious spans, the increased fire risk, and lack of rigidity, are distinct objections. In this respect the buildings are a disappointment—a step backward as compared with previous expositions. All the exhibits are on the ground floors, the small galleries being occupied only by department administration offices. The total area under roof is 250 acres.

The buildings outside the main picture are of almost equal interest, particularly the Palace of Agriculture (page 4) to the west, said to be the largest ever constructed for a single department. There are also the six original Washington University buildings (page 6) magnificent permanent granite structures, Tudor-Gothic in architecture. To these the Exposition has added, as part rental, five similar in character, forming the permanent Washington University group, in which that energetic institution expects to begin its new life immediately after the Fair.

The State and national pavilions are, as a rule, successful structures. Many of them are copies of buildings famous in story and song. Very beautiful are those in the southwestern section of the grounds. Many resemble old country homes, and are surrounded by spacious grounds, winding roadways, stately forest trees, and splendid lawns and gardens.



FESTIVAL HALL, WITH THE CASCADES IN OPERATION.

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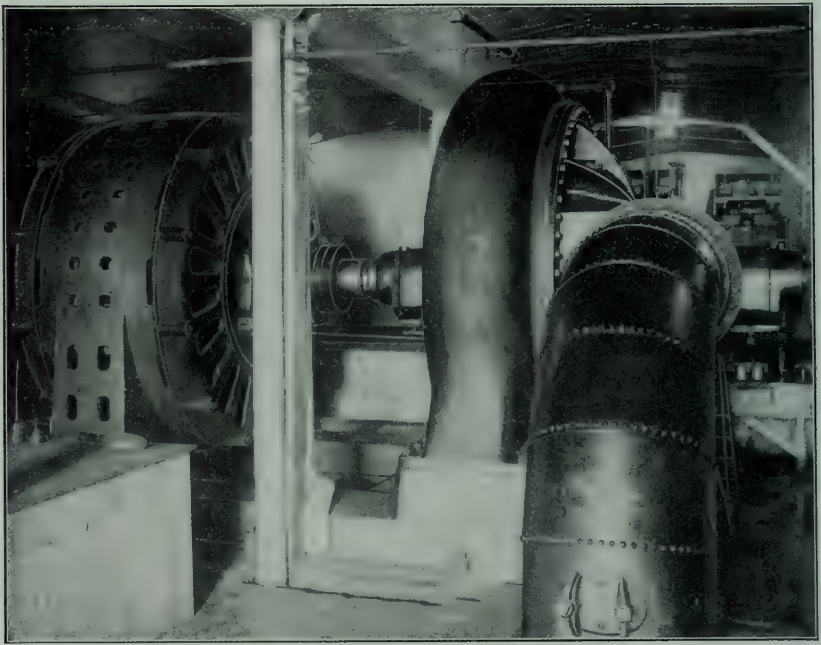
The lagoons surround the Palaces of Electricity and Education, which latter are separated by the main basin. At the south end of the latter are the Cascades, undoubtedly one of the most charming features of the Fair. From each of the three pavilions on the ridge of Art Hill there pours a constant stream of water, the total fall into the main basin being approximately 100 feet. The ledges form numerous falls, ripples, and basins—artificial, of course—but none the less realistic. Underneath the overhanging ledges are placed numberless colored incandescent lights. Along the sides of the cascades are groups of statuary, from which flow streams of water. In the main basin, near the foot of the falls, are three large fountains.



WORTHINGTON TURBINE PUMP DRIVEN BY INDUCTION MOTOR. ONE OF THE SET OF THREE SUPPLYING THE CASCADES.

The power plant controlling this splendid effect is located under the East Cascades. It consists of three Worthington turbine pumps, each of 35,000 gallons-per-minute capacity, working against 160-foot head. Each is direct driven by a 2,000-horse-power induction motor, at 365 revolutions. The plant was designed for a maximum flow of 100,000 gallons per minute, and ample power was provided for the purpose. Some doubt having arisen as to the strength of the cascade framework, however, but one pump is run at a time, and the effect —while impressive—is not altogether what had been anticipated. On the main basin electric and gasoline launches and Venetian gondolas ply, with vari-colored lights, adding greatly to the beauty.

Exceeding even the Cascades in beauty and grandeur is the electrical illumination which begins every day at dusk. Following the successful Buffalo idea, the architectural outlines of the buildings in the main picture are studded with 8-candle-power incandescent lamps, some 140,000 being employed. Many of these are located behind columns and colonades, thus throwing the buildings themselves into relief (page 12). The effect is beautiful and enchanting beyond de-

THE PALACE OF MACHINERY.

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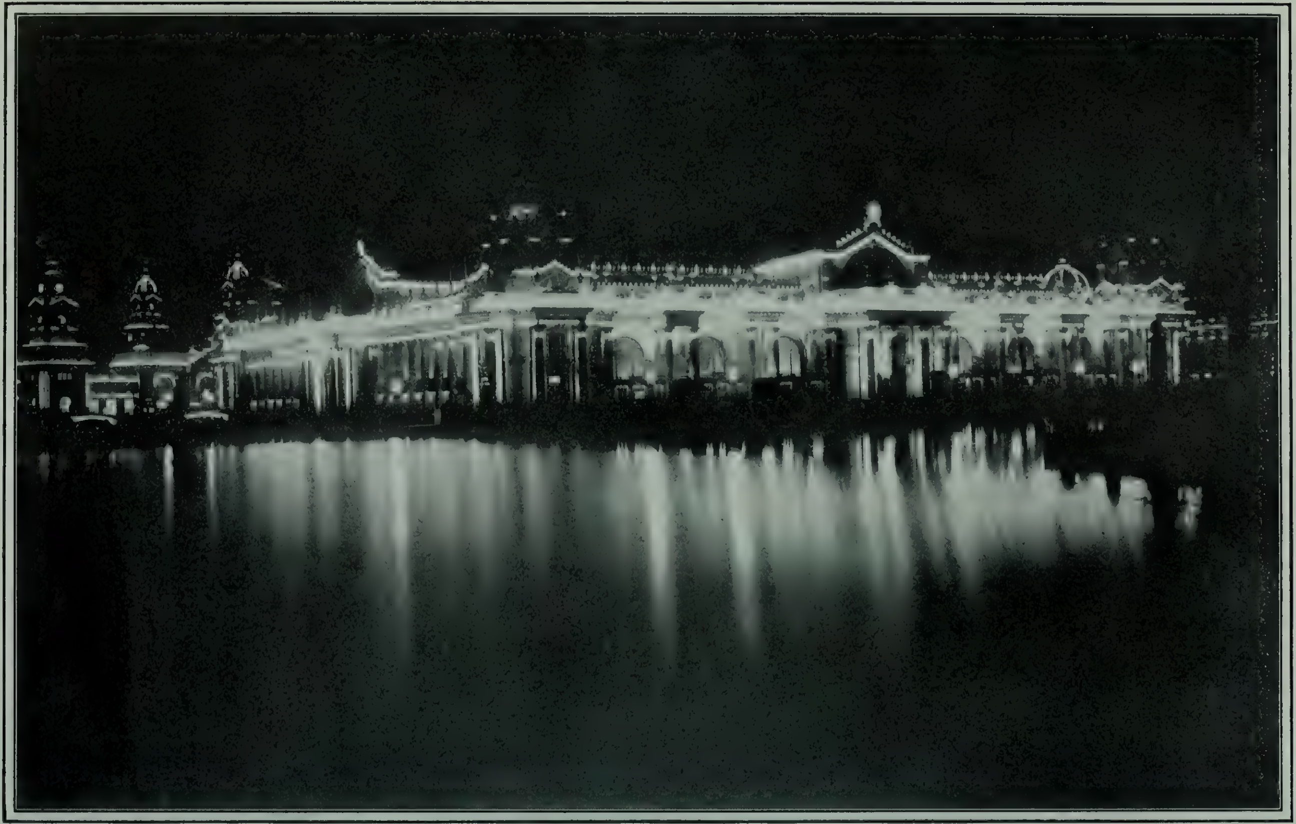


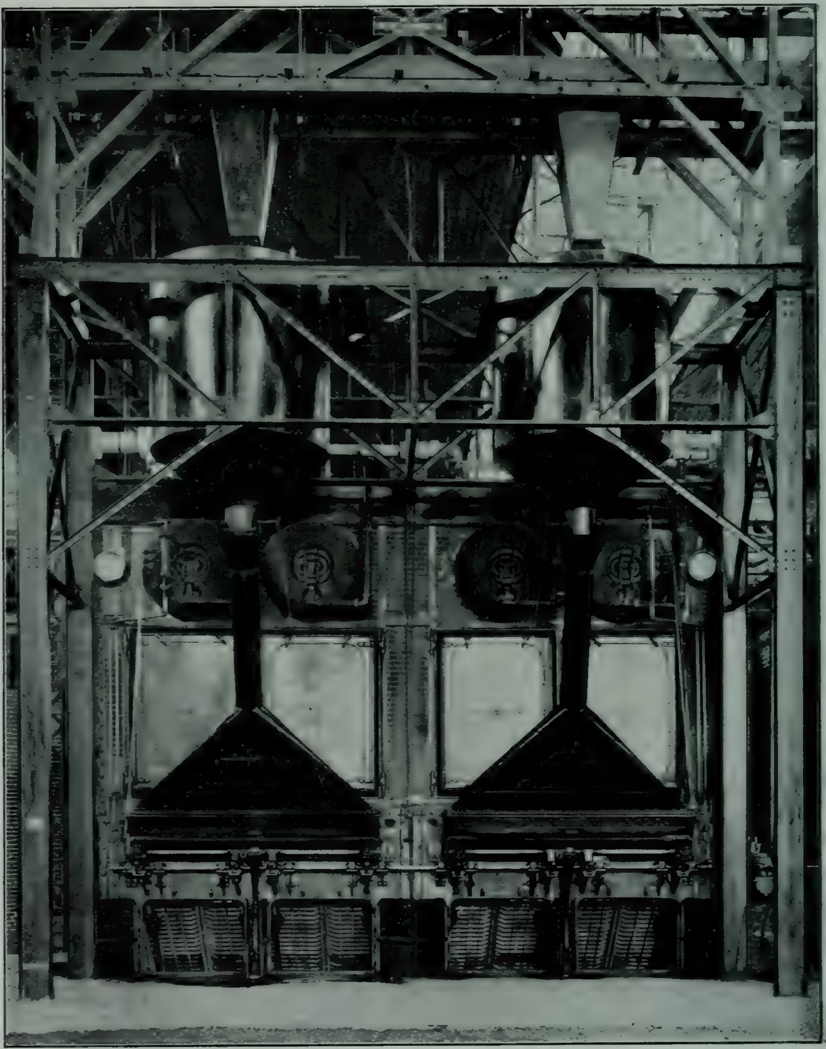
THE PALACE OF ELECTRICITY BY NIGHT.

scription. Festival Hall (shown on page 9), the central Pavilion on Art Hill, the Colonnade of States, and the outer pavilions, are so wired that the colors may be changed. The lamps are located in groups of three, red, white, and green, each color on an independent circuit. These colors are changed by means of switches every few minutes, with splendid effect. No more perfect picture can be imagined than is afforded by a night trip around the lagoons, the summer moon in the heavens, the water craft passing to and fro with gaily colored lanterns, the splendid illumination on every side, the brilliantly changing colors on Art Hill, the reflections in the water, all attuned to the deep undertone of the cascades. Certainly the popular verdict which long since selected this as the crowning feature of the Fair—exceeding indeed all previous Fairs—has not gone astray.

The service power plant of the Exposition, located in the west end of the Palace of Machinery, presents many interesting features, although it involves nothing particularly novel or striking. About one-third of the apparatus is leased, and two-thirds was installed by exhibitors. The boiler plant is located in the Steam, Gas, and Fuels Building, a plain structure, located just west of the Palace of Machinery. There are 52 independent boilers, all of standard horizontal and vertical water-tube types, aggregating about 20,000 rated horsepower (page 14). There are seven foreign boilers of the marine type, the Belleville, Dürr, Niclausse, and Schütte. All have induced draft, short steel stacks, and mechanical stokers or chain grates, except six of the smaller units. Neither economizers or superheaters are used, except in the case of the French boilers, which supply superheated steam to the French engine. The pressures carried are 175 for general use, 225 for the steam turbines, and 300 with 200 degrees superheat, for the French engine.

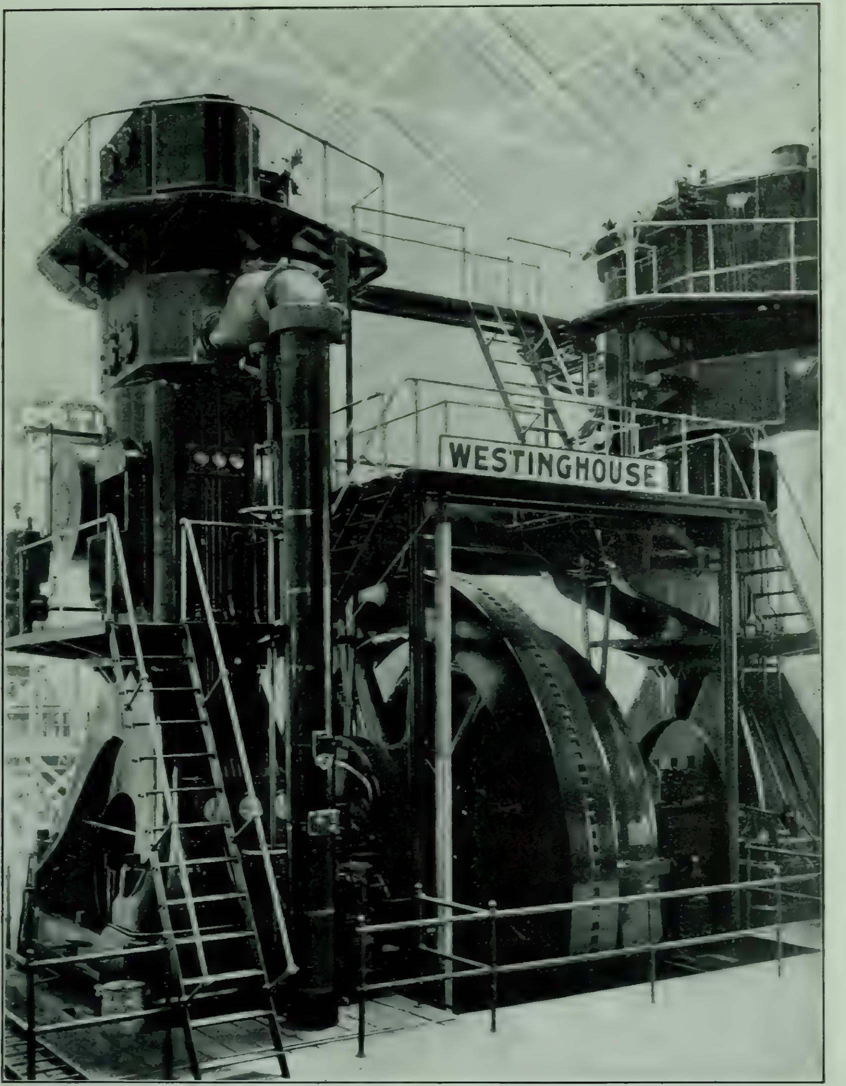
The Exposition owns its own system of coal cars, which are of the 50-ton hopper-bottom type, and can be dumped in 8 minutes. The coal is then conveyed to crushers and elevated to 500-ton bunkers, from which it is fed directly to the stokers. The ashes drop from chutes into metallic cars in tunnels, and are then conveyed and elevated into cars. About 70 per cent. of the boilers are required for the maximum load, and an average of 500 short tons of ordinary bituminous coal from Troy, Ill., is consumed per 24 hours. The smoke record is fair, although not as good as the present state of the art would lead one to expect. Many interesting details may be noted, such as the various types of feed pumps, heaters, purifiers, flue cleaners, etc. Lack of stability of the framework of the buildings made it necessary to support all the pipe work from below.

Space will not permit further details regarding the capacity, make, and type of the boiler units, nor for the engines and generators. These latter aggregate about 35,000 rated horse power, and represent good modern practice, and are interesting in many respects, although they represent nothing particularly remarkable. The engines are both vertical and horizontal, of the Corliss (pages 15 and 16) and



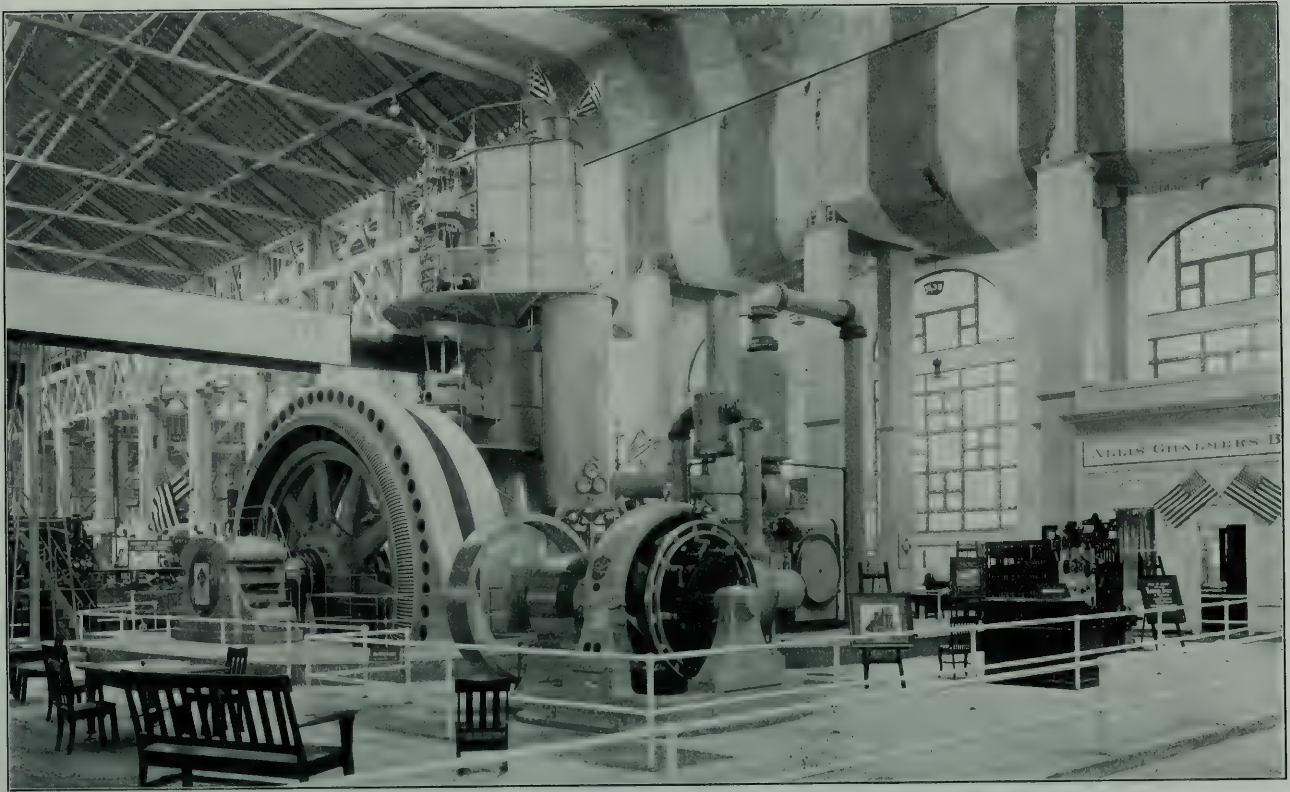
BOILER BATTERY, STEAM AND FUEL BUILDING.

Showing equipment with Roney mechanical stokers, receiving coal from overhead hoppers.



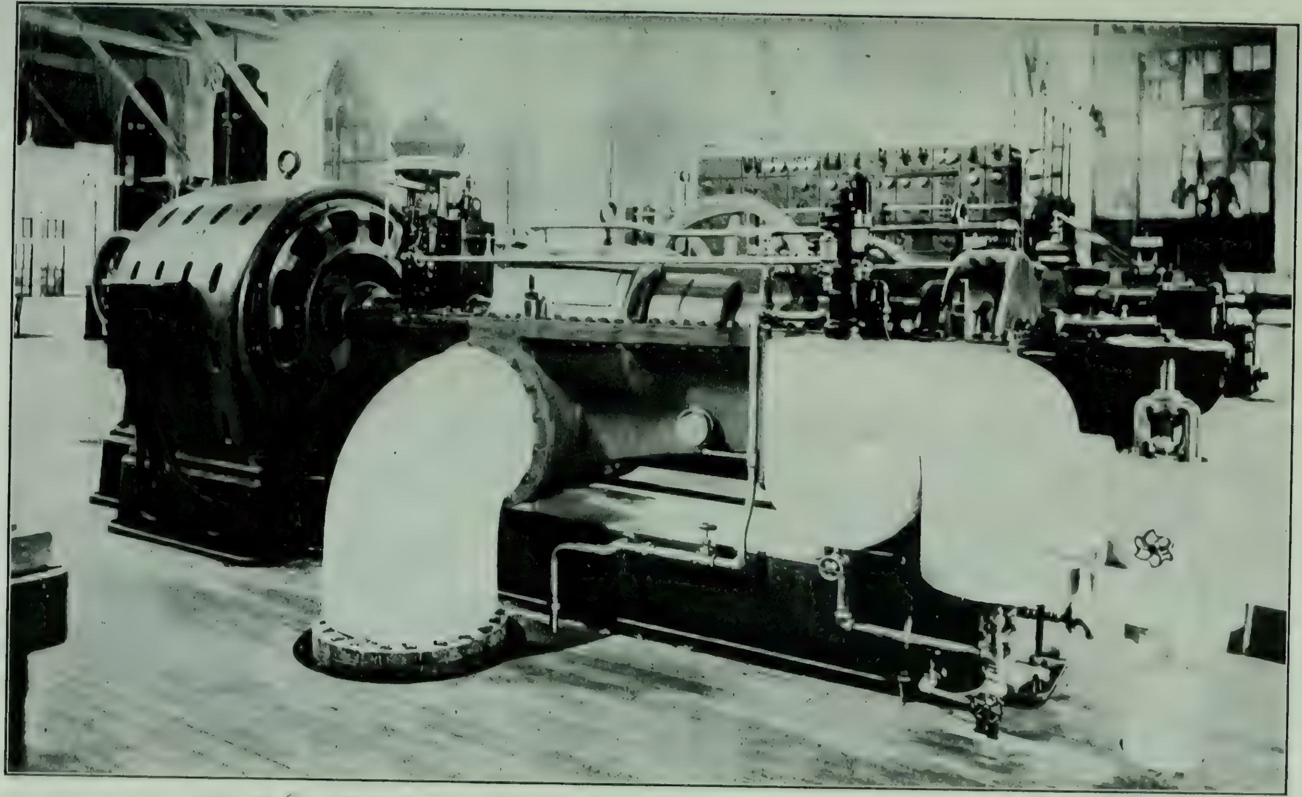
THE 3,500-HORSE-POWER WESTINGHOUSE CORLISS ENGINE, IN THE EXPOSITION SERVICE PLANT, MACHINERY HALL.

other well-known American types. All are compound condensing, except a Willans, and the DeLaunay-Belleville French steam engine, a six-cylinder quadruple-expansion, of the marine type, for 300-pounds initial pressure, with generator, exciter, condenser, circulator, and air pump, all on one base. All the prominent makes of steam

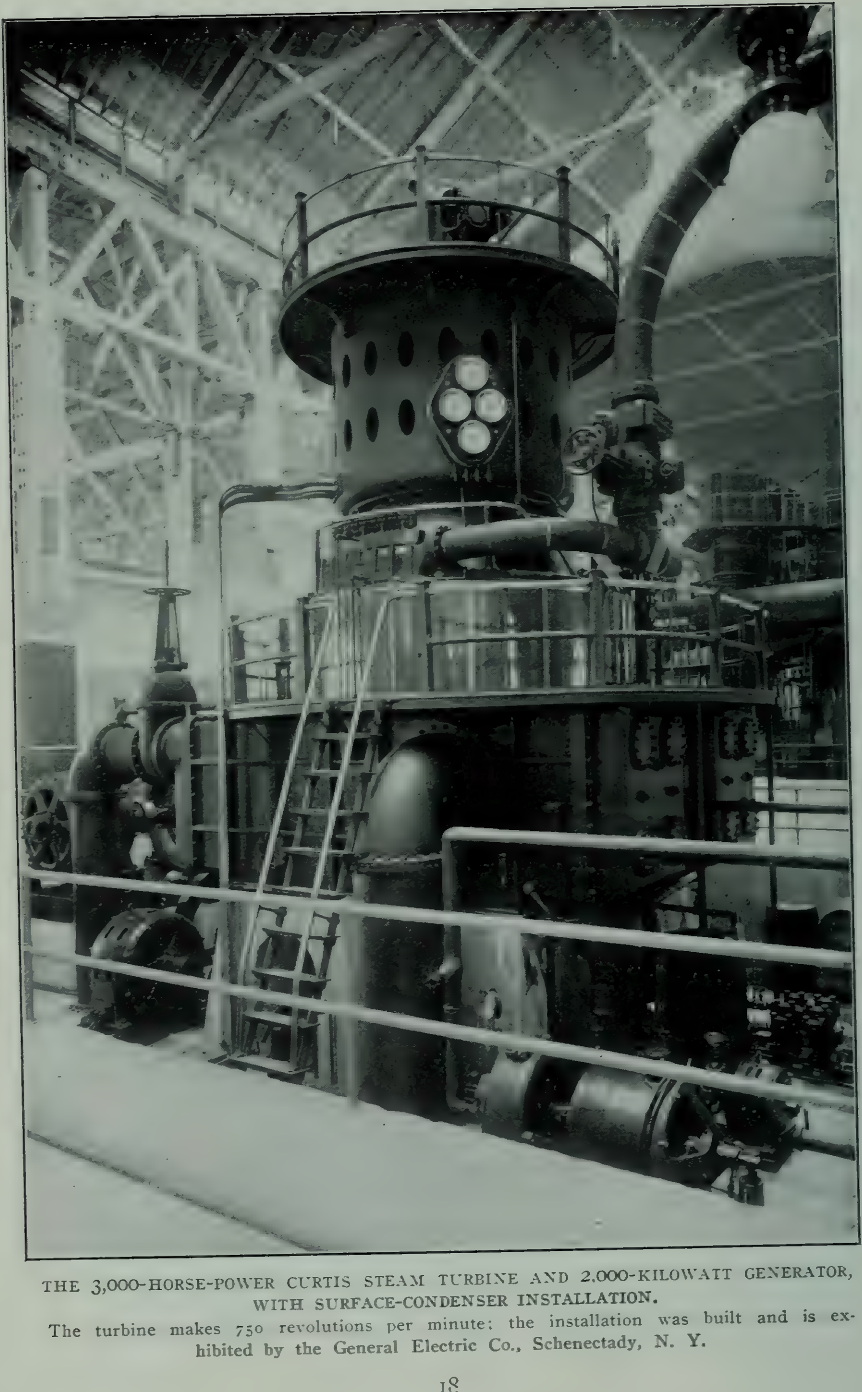


THE ALLIS-CHALMERS-BULLOCK POWER INSTALLATION WHICH FURNISHES CURRENT FOR DECORATIVE LIGHTING ON THE MAIN EXHIBIT PALACES.

A 5,000-horse-power engine and 3,500-kilowatt generator.



VIEW OF 600-HORSE-POWER WESTINGHOUSE-PARSONS STEAM TURBINE, IN MACHINERY HALL.
Photographed in operation, at 9.30 p. m., by the light of Cooper-Hewitt mercury-vapor lamps.



THE 3,000-HORSE-POWER CURTIS STEAM TURBINE AND 2,000-KILOWATT GENERATOR, WITH SURFACE-CONDENSER INSTALLATION.

The turbine makes 750 revolutions per minute; the installation was built and is exhibited by the General Electric Co., Schenectady, N. Y.

turbines are represented, although none are of record-breaking size, the 2,000-kilowatt Curtis shown on the opposite page being the largest. Next in size is the 1,000-kilowatt Hamilton-Holzwarth, which being of a new type will be watched with interest. The 400-kilowatt Parsons horizontal turbine (page 17), which was put into operation on June 27, is to be kept in continuous service until the close of the Exposition. Some small DeLaval turbines are on exhibition in the Palace of Machinery, and others, driving generators and centrifugal pumps, are in motion in the Mining Gulch, shown below. The maximum or peak load on the main service plant is about 13,500 kilowatts.

DE LAVAL STEAM-TURBINE EXHIBIT IN THE MINING GULCH.

Showing steam turbines, generators, centrifugal pumps, and motors.

A serious disappointment is the absence of large gas engines. Two large foreign engines were expected, but a misunderstanding arose as to gas supply and erection charges, which led to their withdrawal. A 75-kilowatt Weber engine, with producer complete, burning charcoal, is in operation in the Gas, Steam, and Fuels Building, and a 250-horse-power Westinghouse in the Government fuel-testing plant in the Gulch. Two small Westinghouse gas generators and engines—one 225-horse-power horizontal and one 125-horse-power vertical, both shown on page 21, have been erected in the Palace of Machinery, and are running on city illuminating gas.

Almost every imaginable make and form of electrical generation and distribution for light and power may be found, alternating and direct, at various voltages. Transformer stations are located at the main plant, and at various centers of distribution. The distribution is wholly by underground conduits.

In the power plant the auxiliaries are noticeable. All the principal types of barometric and surface condensers are in use. Many dry vacuum pumps are in operation, also a number of rotary and centrifugal pumps. Cooling towers are used for part of the condensers, while water which has passed over the cascades is drawn from the lagoons for the balance. It is difficult to understand why the latter plan was not employed for the entire cooling system, as was done at Paris.

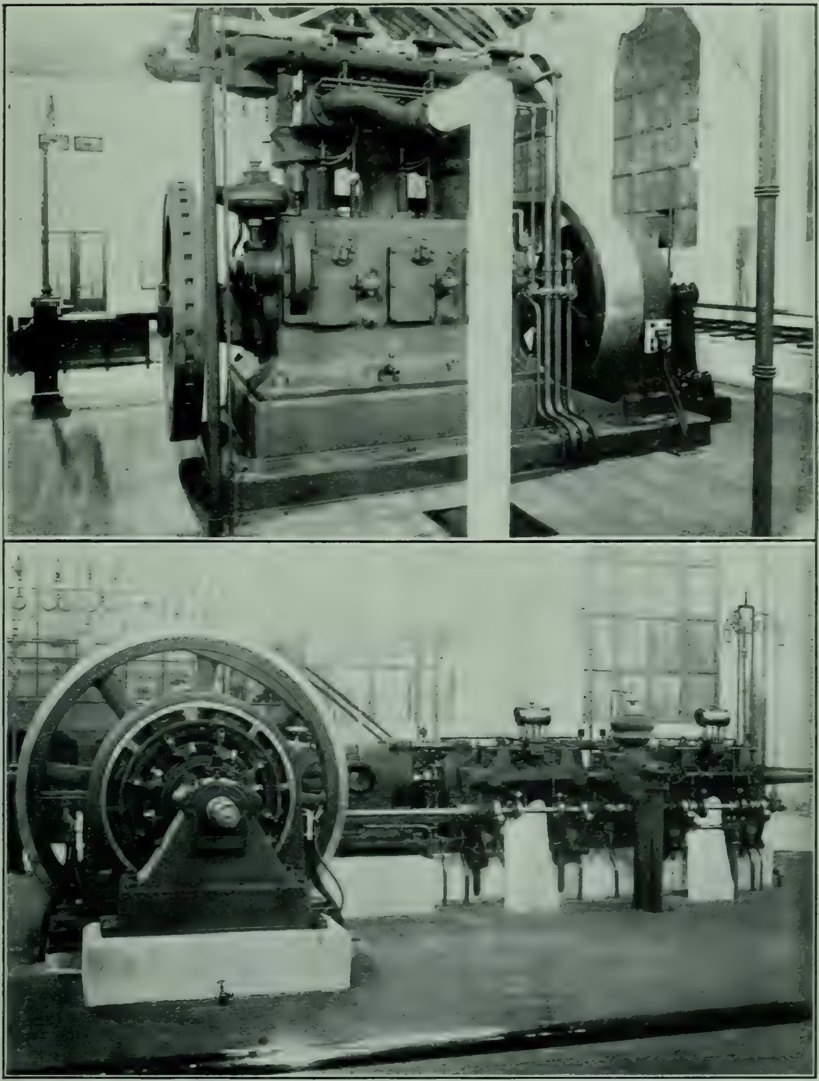
Among the concessions there are many interesting engineering features. The lighting of the Tyrolean Alps is from generators driven by Diesel motors, three units of 250 indicated horse power each being in operation, burning a light-gravity fuel oil, or distillate, from the Indiana fields, costing 4 cents per gallon. The fuel is injected by air supplied from independent motor-driven compressors. In the Philippine reservation the Government operates its own power plant, and incidentally exhibits many interesting details, such as the Filipino houses, water craft, manufactures, etc.

The Exposition organized its own system of collecting and disposing of garbage, erecting a 60-ton exhibit cremation plant for the purpose. All combustible matter is burned in the furnaces, and the sweepings, etc., are hauled away to dumps.

Much was expected originally of the department of refrigeration and ice making, whose display was to have been one of the features of the Fair. For some reason, however, the plan was abandoned, and the only exhibit of this kind is a 500-ton temporary plant operated as a concession, for the supply of ice on the grounds, and for circulating brine through refrigerator boxes, the underground lines extending some 7,000 feet from the plant. It represents good ordinary practice, but has no special or novel features.

Worthy of note are the ingenious methods of supplying power to machine tools, as shown in the Palaces of Machinery, Electricity, (page 22) and Manufactures. The individual motor drive, the combination of small machines into groups driven by a single motor, and the many ingenious methods of speed variation, will repay study.

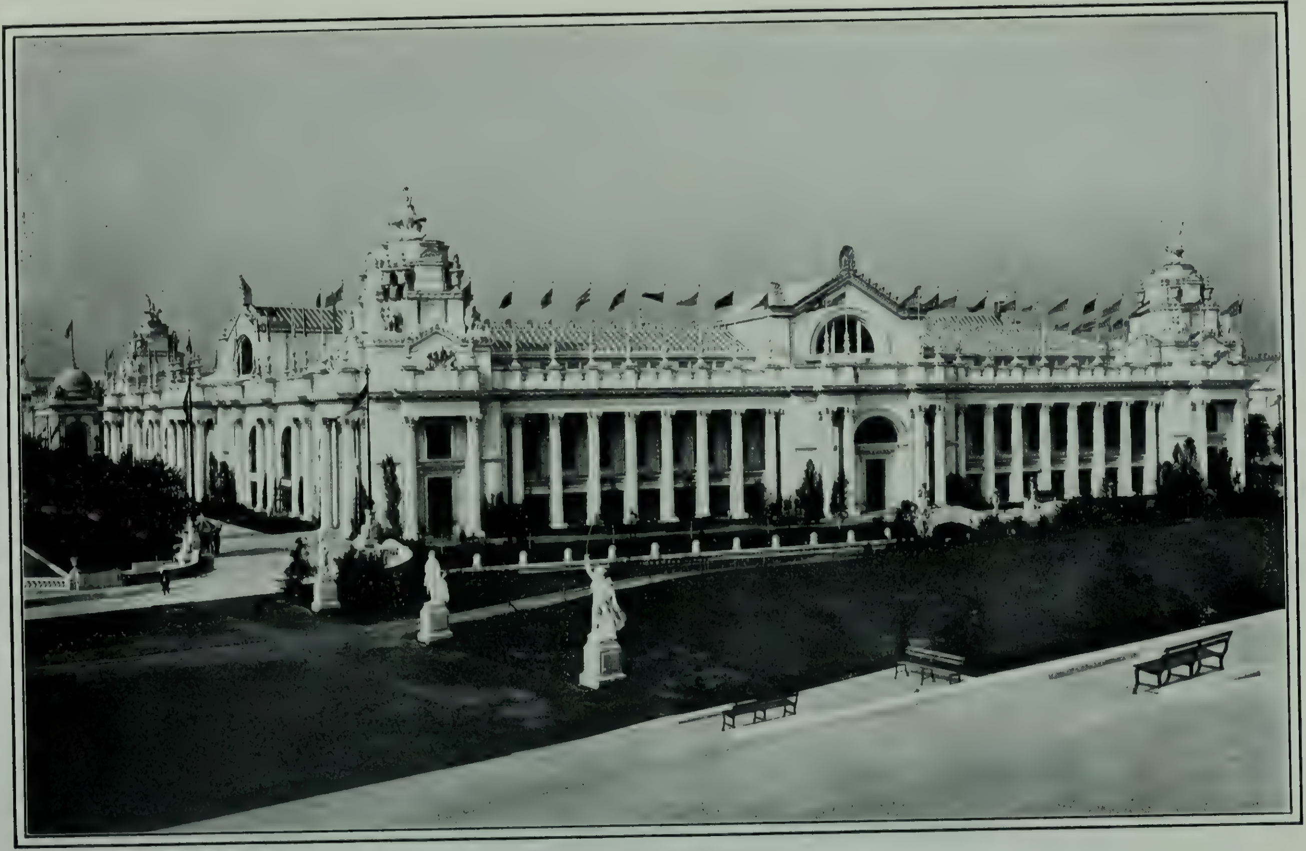
Of great engineering interest is the coal-testing plant of the United States Geological Survey, erected and operated in the "Gulch" under an appropriation from Congress (page 23). The equipment consists of steam boilers, steam engines, electric generators and motors, a



WESTINGHOUSE GAS ENGINES IN MACHINERY HALL.

Above is a 125-horse-power vertical single-acting gas engine; below is a 225-horse-power horizontal gas engine connected to three-wire double-voltage direct-current generator. Both are photographed by Cooper-Hewitt light.

complete gas producer, with economizer, scrubber, and holder, beehive coke ovens, a vertical gas engine, crushers, washers, driers, bins, one English and one American briquetting press, with outfits complete. There is also a complete plant of boiler- and engine-testing apparatus, and a well-equipped chemical laboratory, where calorific



THE PALACE OF ELECTRICITY.
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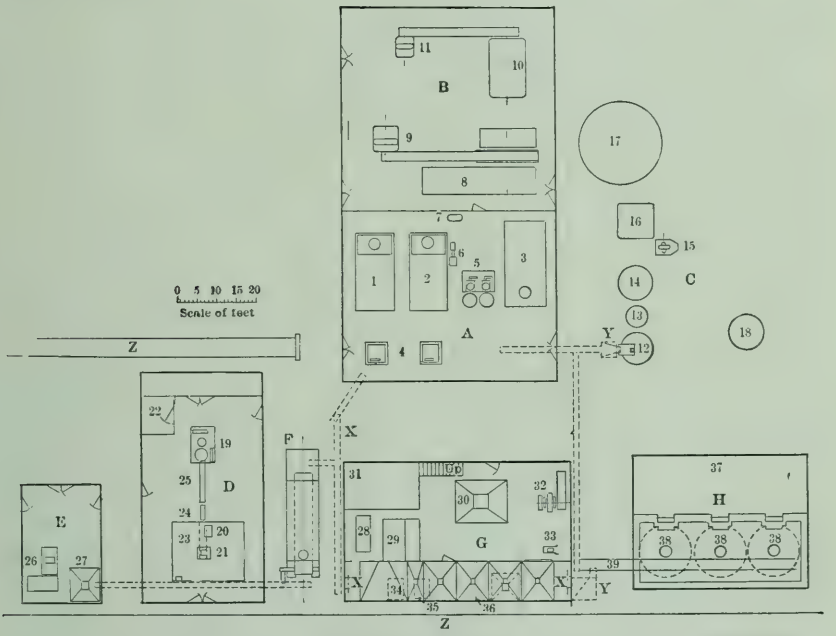
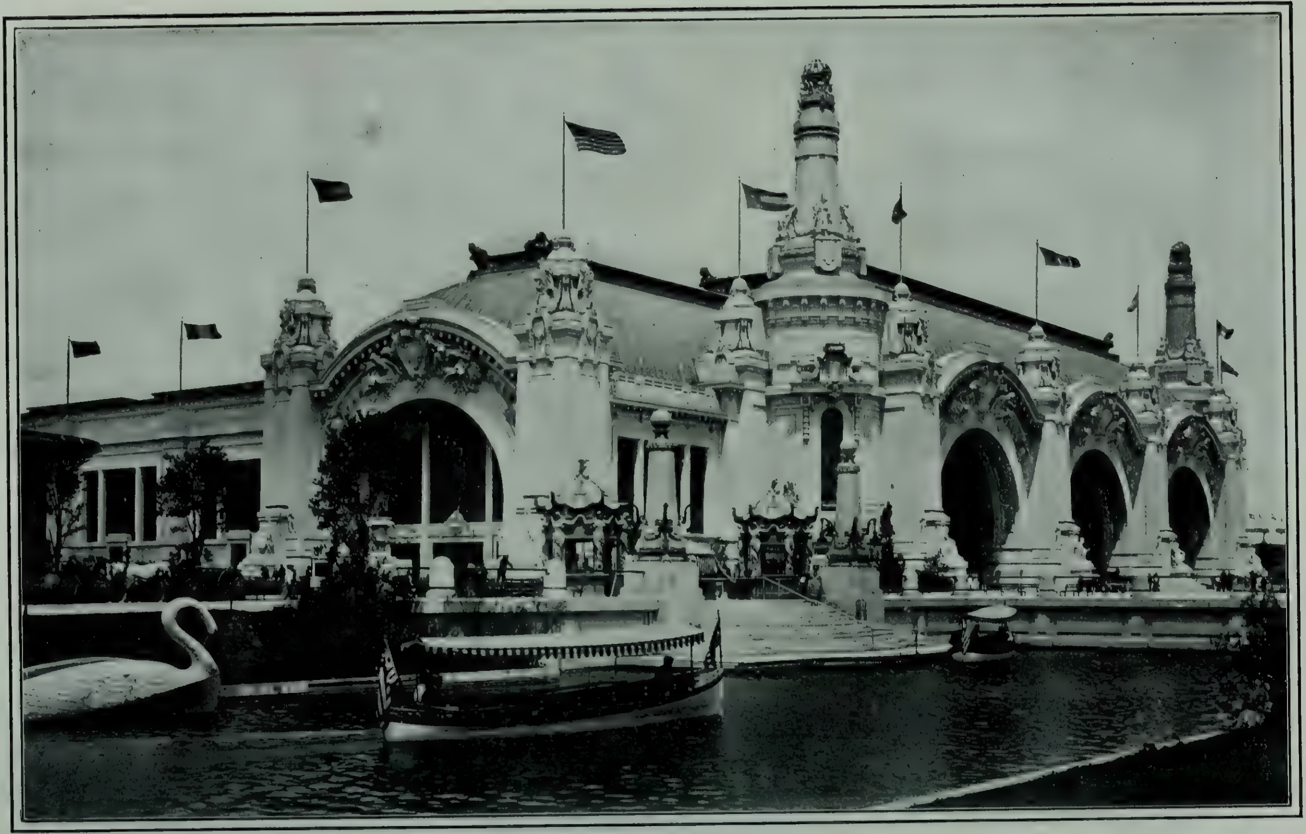
determinations and proximate and ultimate analyses of each fuel are made. All this work is in the hands of specialists of long training. The samples to be tested are selected at the mines by experts sent out for the purpose. On arrival, part of the coal is put through the gas-making plant, part through the coke ovens, part tested under the boilers, and part goes to the briquetting machines. A 250-horse-power gas engine is located along-side of a 250-horse-power Corliss engine, and both connected to electric generators. The coal will be transformed into electrical energy by both the steam and gas processes, and the results compared. The coke from the ovens will be analyzed, and then carefully tested in the Model Foundry near by. Both the equipment and the fuels are furnished to the government without charge.



UNITED STATES GEOLOGICAL SURVEY FUEL-TESTING PLANT, ST. LOUIS EXPOSITION.

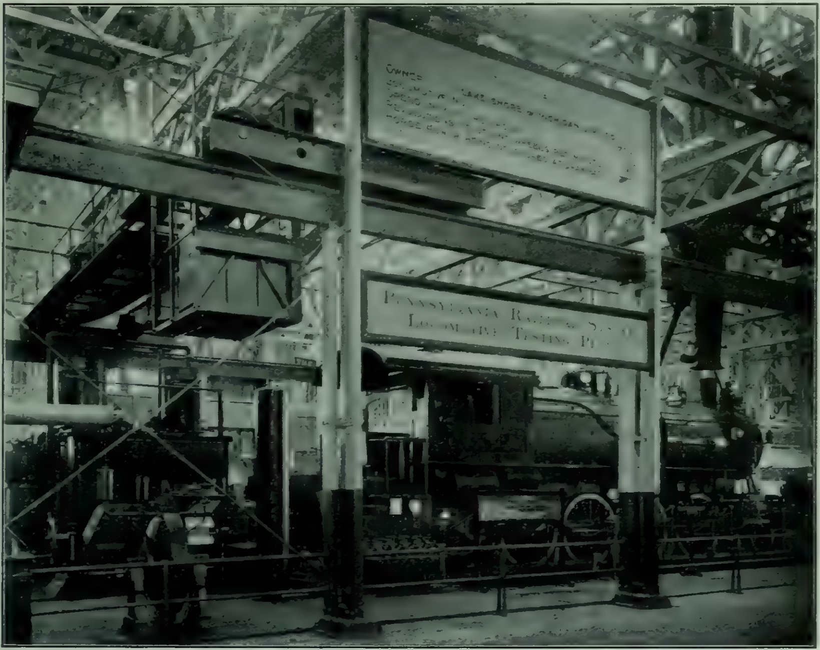
Key to the lettering:—A, Boiler house; 1 and 2, Heine boilers; 3, fire-tube boiler; 4, coal weighing scales; 5, water ditto; 6, feed pump; 7, feed-water heater. B, Engine room; 8, 9, Allis-Chalmers-Bullock engine and belted generator; 10, 11, gas engine and belted generator. C, Gas producer; 12, R. D. Wood & Co. producer; 13, economizer; 14, scrubber; 15, tar-extracting fan; 16, purifier; 17, gas holder; 18, Foster gas producer. D, Briquette machine, Wm. Johnson & Sons, Leeds; 19, briquette machine; 20, pitch cracker; 21, hopper; 22, office; 23, mixer; 24, elevating fan; 25, elevator; E, Chisholm, Boyd & White briquette plant; 26, eggette machine; 27, hopper and storage bin; F, Bartlett-Snow dryer. G, Washery; 28, Century jig; 29, Link Belt jig; 30, sludge tank; 31, operating-platform; 32, steam engine; 33, centrifugal pump; 34, Williams mill; 35, roller crusher; 36, hoppers. H, Coke ovens; 37, wharf; 38, La Clede Firebrick Co. ovens; 39, larry track; X, conveyors; Y, storage bins; Z, track sidings.



THE PALACE OF TRANSPORTATION.

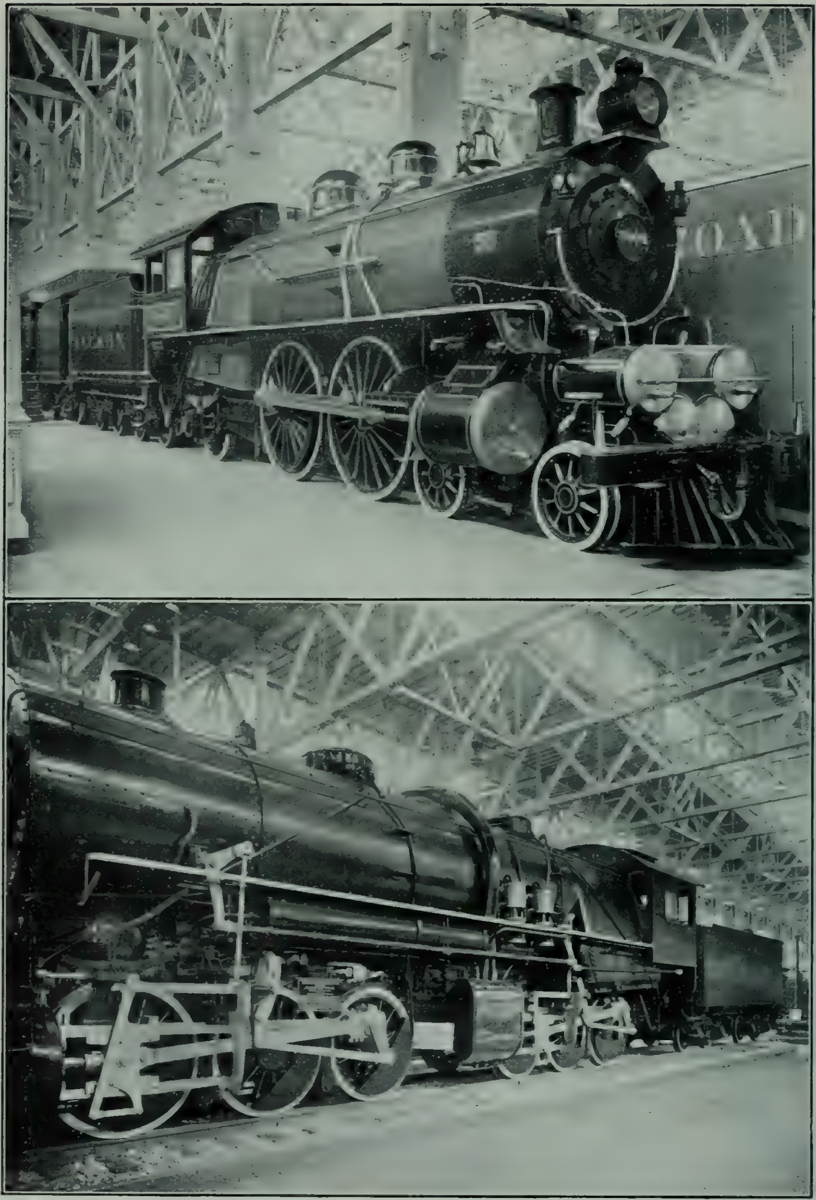
Another installation of interest to engineers is the timber-preserving plant, located in the upper end of the Gulch, and operated by the Bureau of Forestry. Here the various processes for preserving railway ties and other timber will be tested. Afterwards sample ties of each lot are to be put into tracks in regular service, and careful records kept of the life and behavior of each tie.

The Model Foundry, also located in the Gulch, was built by the Exposition, and will interest many engineers. There the best apparatus and processes in modern foundry work have been erected and are in regular commercial operation. Improved cupolas, cranes, and moulding machines of all classes are shown.



THE PENNSYLVANIA RAILWAY LOCOMOTIVE-TESTING PLANT.

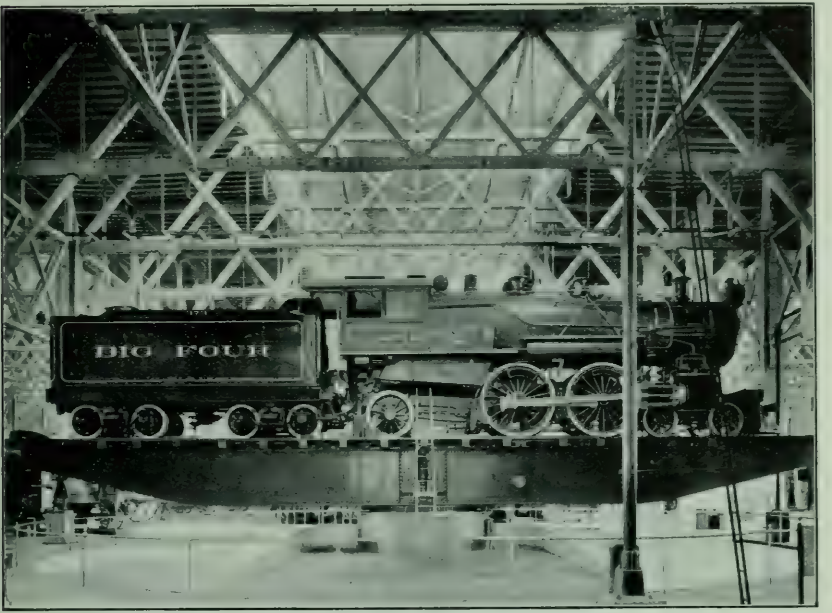
Engineers, particularly those interested in transportation, will find much to study in the locomotive-testing plant, erected and operated by the Pennsylvania Railroad in the Palace of Transportation. The equipment, as shown, is elaborate, and the engineers in charge are experts. Locomotives of various makes and types are being put through exhaustive tests, under varying conditions, at changing speeds, and with different fuels. This is the most exhaustive study of the locomotive ever made, and the results will be of great benefit. Bulletins are prepared and the results are to be published.



LOCOMOTIVES IN THE PALACE OF TRANSPORTATION.

Above is a N. Y. C. & H. R. engine built by the American Locomotive Co.—a four-cylinder balanced compound; the high-pressure cylinders are between the frames and drive the forward axle, the low-pressure outside, driving the rear axle; the cylinders are 15½ and 26 by 26 inches, heating surface 3,446 sq. ft.; pressure 220 lb., weight 200,000 lb. Below is a B. & O. articulated compound, Mallet system, carried on two groups of six drivers each; the high-pressure cylinders drive the rear group, which is rigidly connected to the frame, and the low-pressure drive the forward group, which is arranged as a swinging truck. Cylinders 20 and 32 by 32 inches, heating surface 5,585 sq. ft., pressure 235 lb., weight of engine alone 334,000 lb. Said to be the largest engine in the world.

Extensive series of tests of modern electric-railway apparatus and appliances are being made by experts of national reputation, on a line of double-track railway set aside by the Exposition authorities for the purpose.



BIG FOUR LOCOMOTIVE ON TURN TABLE.

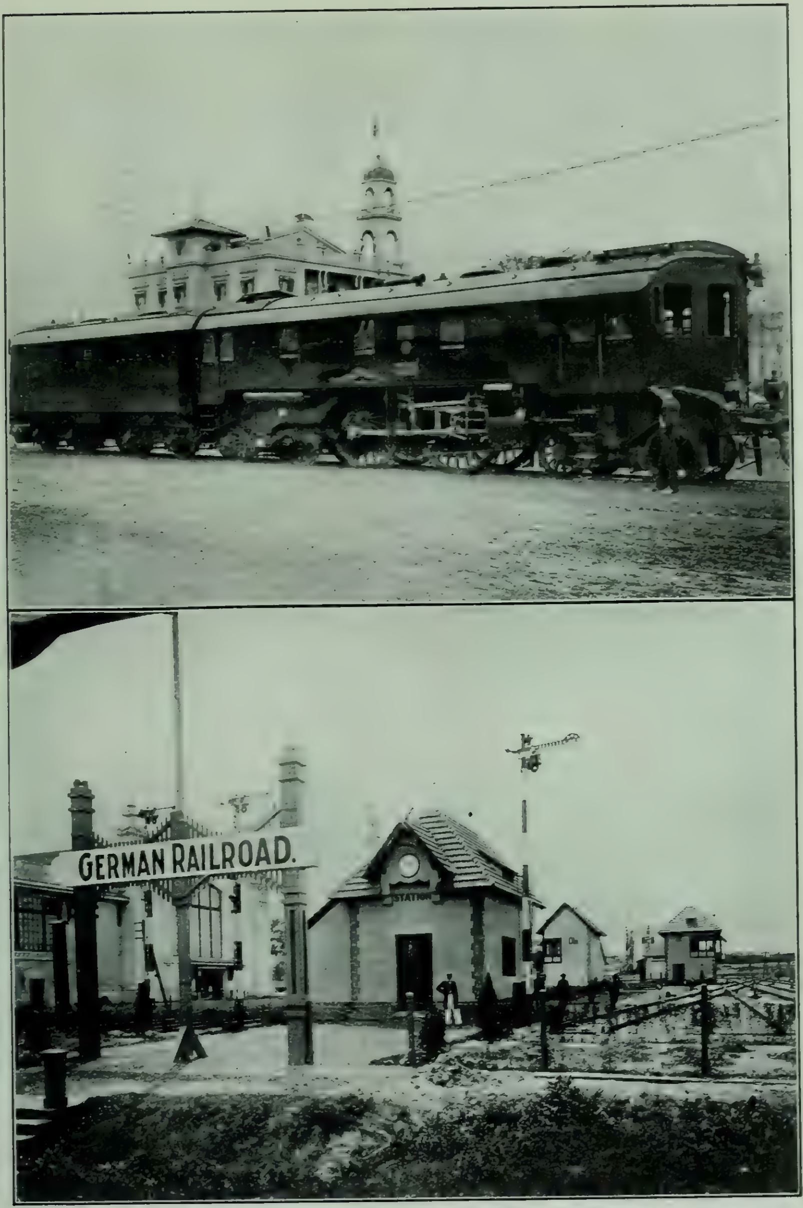
American Locomotive Co. Cylinders 20½ by 26 inches; drivers 79 inches; heating surface 3,196 sq. ft.; steam-pressure 200 lb.; weight of engine alone, 184,000 lb.

The engineering installations and exhibits are of such a varied character, and present so many interesting details, as to require far more space for their proper presentation than is available here. Only the principal features can therefore be discussed. The large and modern types of locomotives in the Palace of Transportation (pages 26, 27, 29, and 30) are of decided interest. Exhibits show both the largest (page 26) and the smallest locomotives in existence, the latter operating the miniature concession railway. A number of electric locomotives are shown, but none operated by compressed air. Ancient locomotives and tracks are interestingly shown. A German installation (page 29), erected just east of the Alaska Building, covers considerable area, and is an interesting full-sized exhibit of "safety in railroading." Part of the track is laid on wood ties, and attached by screws, and another part is laid on steel ties, the cost being practically the same. The block systems are shown in detail, part being operated by electricity and part by hand.

NORTH ENTRANCE OF THE PALACE OF MINES AND METALLURGY, ABOVE THE SUNKEN GARDEN.

Copyright, 1904, by The Louisiana Purchase Exposition Co.

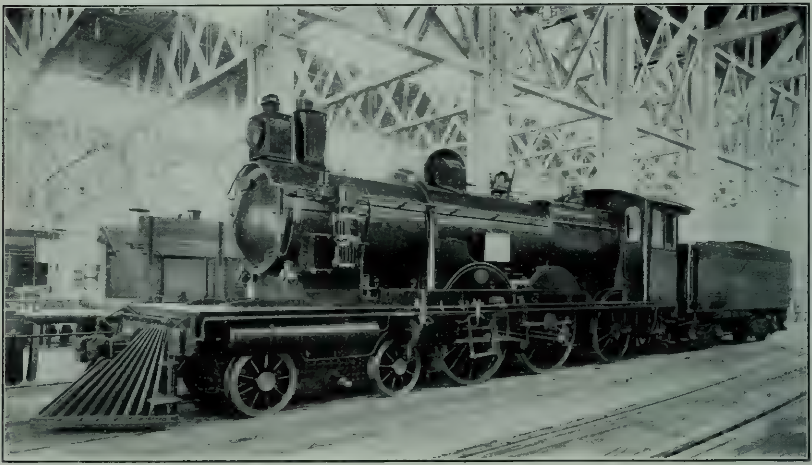
In the Palace of Transportation the exhibits of automobiles occupy a large area. There are many gasoline and electric machines, the former being by far in the majority. Only a few steam wagons are in evidence. On the model street are shown various forms of road and street construction. In the Palace of Mines and Metallurgy a very striking exhibit is the mammoth statue of Vulcan, 56 feet high and weighing 60 tons, exhibited by the city of Birmingham, Ala.



THE OUT-OF-DOOR GERMAN RAILWAY EXHIBIT, AND A HEAVY HIGH-SPEED GERMAN LOCOMOTIVE.

The outdoor exhibit shows stations, switch systems, signals, track, etc. The engine is a three-cylinder balanced compound by Henschel & Sohn, Cassel. The cylinders are all 20⅝ diameter, 24⅞ stroke, the high-pressure driving onto the front axle and the two low-pressure onto the rear; 2,776 sq. ft. heating surface, 200-lb. pressure; weight 85 tons. The cab is at the front end, and engine and tender are enclosed to diminish air resistance.

Much of engineering interest in mining is found in the Mining Gulch south of the Palace of Mines and Metallurgy, where many outdoor exhibits are in operation, including a full-sized working model of an anthracite coal mine.



LOCOMOTIVE FOR THE PENNSYLVANIA R. R., BUILT BY THE SOCIÉTÉ ALSACIENNE DE CONSTRUCTIONS MÉCANIQUES, OF BELFORT, FRANCE.

Four-cylinder balanced compound, de Glehn system; cylinders 14 3-16 and 23 5-8 by 25 3-16; heating surface 2,617 sq. ft.; pressure 227 1-2 lb.

Our old friend, the Ferris Wheel, now in its third location, is proving as interesting and successful as ever. As is well known, this wheel is 250 feet in diameter, and weighs 4,200 tons. Its dismantling in Chicago and its transportation and erection in St. Louis presented many interesting engineering problems. It is unfortunate, however, that it is now located on the lower instead of the higher level at the Fair.

Not the least interesting feature is the extent to which exhibits are in motion. Wherever possible, the machinery prepares the finished product under the visitor's eye. Particularly interesting are the plants spinning cotton, making shoes, incandescent lamps, and a distillery, numerous bakeries, and an electrical kitchen. The extensive use of maps, both plane and profile, and of complete models, is noticeable. Scattered all over the grounds are exhibits of moving pictures, showing a wide variety of subjects. So extensive is this method of advertising that it may well be termed one of the features of the Fair.

A characteristic development of the times is the almost total absence of belts, both in generating plants and in the power-distribution and motor installations. Those interested in modern electricity may

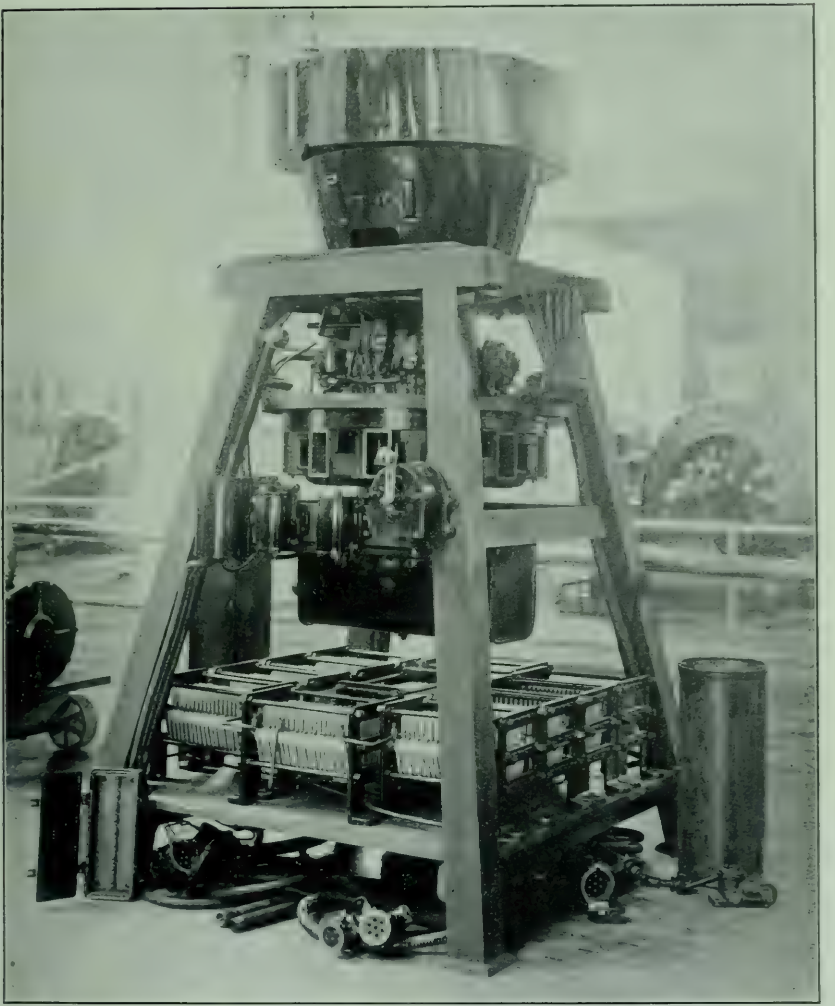
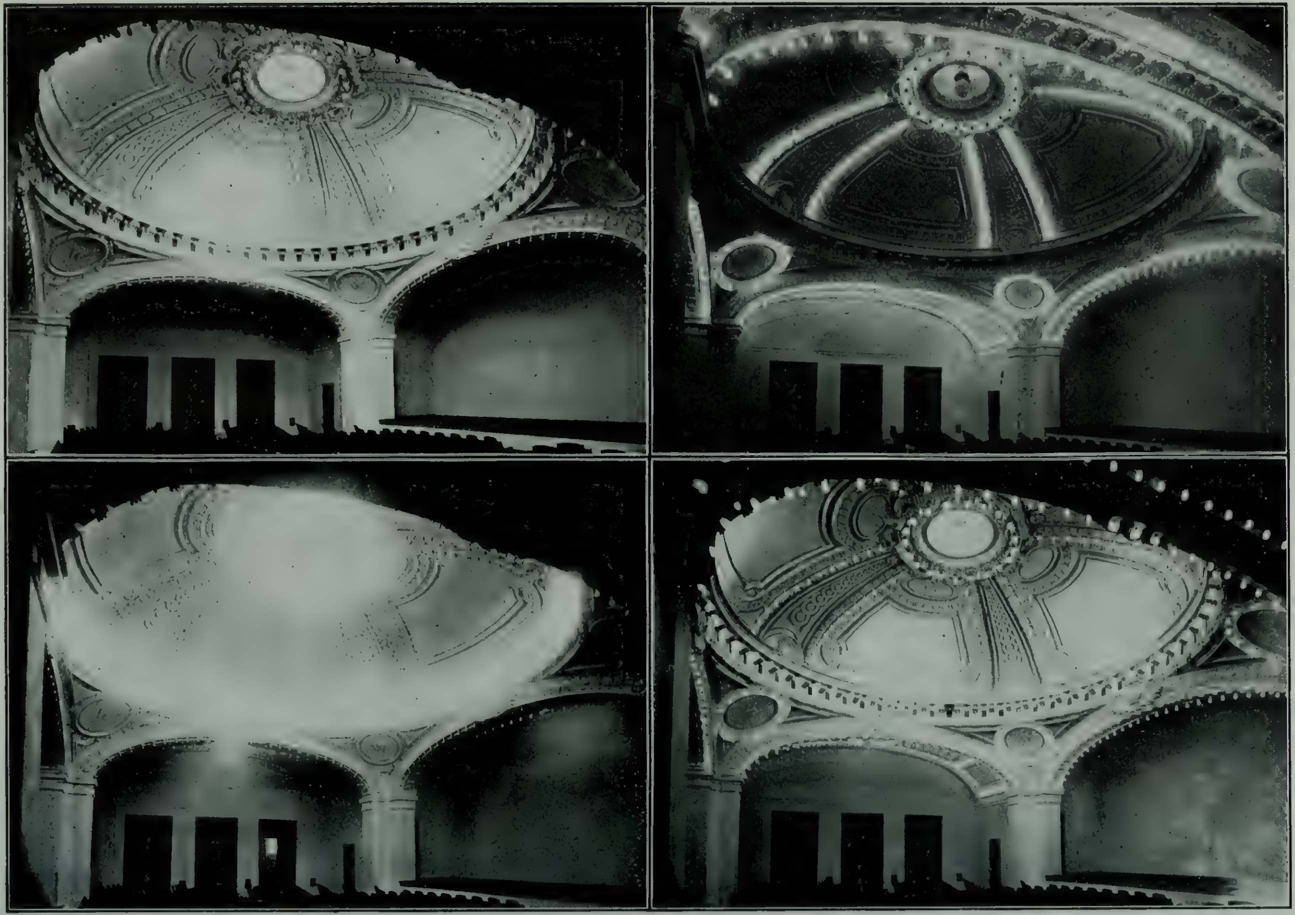


EXHIBIT OF PARTS, WESTINGHOUSE UNIT SWITCH SYSTEM OF MULTIPLE CONTROL. IN THE PALACE OF ELECTRICITY.

spend their time profitably in studying the many forms of alternating- and direct-current generation and distribution, the new switchboards, automatic telephone systems, wireless telegraphy—unfortunately in limited use at the Fair—the wireless telephone, rapid telegraphy, the Edison historical exhibit, the talking arc lamp, the extensive use of Nernst lamps, the Bremer arc lamp, and the Cooper-Hewitt mercury-vapor lamps. Much of interest to the engineer will be found also in the Palace of Education, where the equipment and accomplishments of many leading engineering schools are shown.



A COMPARISON OF SYSTEMS OF ELECTRIC LIGHTING, IN THE WESTINGHOUSE AUDITORIUM, MACHINERY HALL.

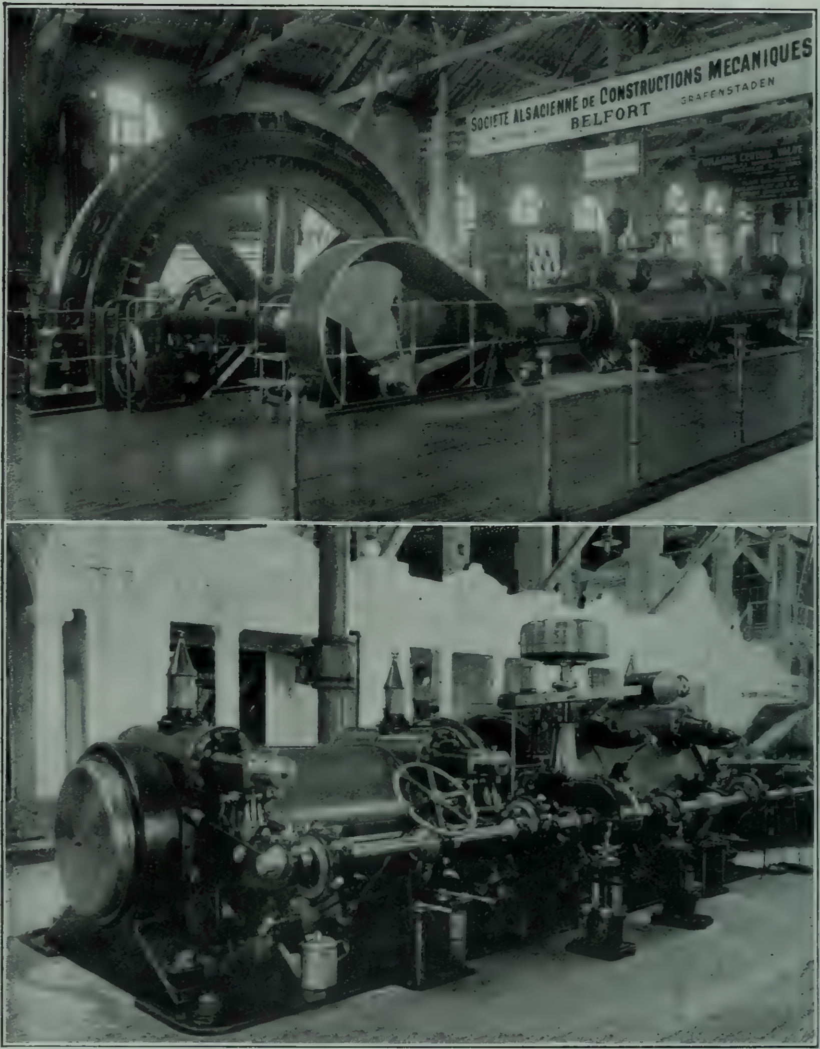
The upper illustration on the left shows the effect of lighting by Cooper-Hewitt lamps; next to that, on the right, the illumination by Sawyer-Man incandescent lamps. The lower view on the left shows the hall when lighted by Nernst lamps, while the effect in the lower right view is produced by the combination of Cooper-Hewitt mercury-vapor lamps, Sawyer-Man incandescents, Nernst glowers, and Bremer arc lamp.

No single engineering feature bears the same relation to this Fair that the Eiffel Tower did at Paris, or the Ferris Wheel at Chicago. There is, nevertheless, an immense amount of matter which will repay investigation, and a young engineering student could better forego a year at school than miss these opportunities. An investigator with a seeing eye and a discerning mind could occupy profitably every hour from the opening of the Exposition to its close. Few, of course, can give this much time, but an entire month could be well spent, and no engineer should remain less than a week.

Engineers differ as to the leading engineering feature of the Fair. Much depends upon the point of view. While neither the cascades, the illumination, nor the landscape engineering, present particularly novel features, yet the combination forms a grand and impressive piece of engineering. Of great practical benefit are the government fuel-testing and the locomotive-testing plants. The absence of belted machines, the distribution of power by electricity, the almost universal use of direct-connected motors, are hardly less notable. Epochs are here marked by the steam turbines, gas engines, and new forms of electric lamps.

While the Louisiana Purchase Exposition is magnificent from many points of view, and of such general interest as to appeal to all classes—and particularly to the engineer—it is a matter of regret that in some important directions the fullest engineering possibilities have not been realized. The money available, and the financial and moral backing of the United States Government, were ample grounds for expecting a stupendous exhibition. That this high result was not reached was due in part no doubt to the lack of recognition given the engineering profession, and also to the fact that the results aimed at were too great for even the splendid financial resources of this Fair. The work cost much more than it should. This was due largely to two causes:—First, the extreme haste necessary; and, second, the exactions of organized labor, the detailed story of which would form interesting reading indeed. Advantage was taken of the necessities of the Fair, and the scarcity of labor—often artificial,—to enforce outrageous demands of every kind.

Those who have watched the progress of this enterprise from its inception, and who know the difficulties which had to be met, stand in admiration and awe at the splendid result. The final judgment of the critic who tries to be just, must, after all, be one of honor and congratulation, and not of petty criticism that some features have fallen short of the highest standards. Possibly no single visitor will find all



TWO VIEWS OF THE 1,000-HORSE-POWER HORIZONTAL TANDEM-COMPOUND STEAM ENGINE AND 700-KILOWATT, 2,300-VOLT, THREE-PHASE ALTERNATOR, BY THE SOCIÉTÉ ALSACIENNE DE CONSTRUCTIONS MÉCANIQUES.

The engine was built at the Mülhausen works, the generator at Belfort. The complete installation includes also surface condenser, vertical direct-driven air pump, electric-driven centrifugal pump, exciter, transformer, switchboard, alternating-current motor for circulating pump, and starting engine. It supplies current for the Exhibition arc-lighting service.

that he expected, but none will go away without an over-powering impression of the wonders he has seen. From whatever standpoint he has viewed the Fair, the general result will not be disappointing.

AN EARLY WORSDELL COMPOUND FOR THE GREAT EASTERN RAILWAY.

THE DEVELOPMENT OF THE COMPOUND LOCOMOTIVE IN ENGLAND.

By W. E. Dalby.

Professor Dalby's preceding article dealt with the work of Mr. F. W. Webb, the pioneer of the compound locomotive in Great Britain and one of its strongest advocates anywhere. The following paper concludes the review by a study of the work of the other British engineers who have been prominent in the development of the compound locomotive.—The Editors.

At the same time that compound locomotives were being tried on the London and North Western Railway, Mr. T. W. Worsdell was building a two-cylinder compound of the inside-cylinder type, the engine being jointly associated with the names of Mr. Worsdell and von Borries. The first of the kind was an express passenger engine built for the Great Eastern Railway Company, a photograph of which is shown just above. The high-pressure cylinder was 18 inches diameter and the low-pressure 26 inches, both having a stroke of 2 feet. The principal mechanical feature of this type was the arrangement used for starting the engine when the high-pressure valve happened to cover both steam ports. This will be understood from the diagrammatic arrangement, sketched in Figure 6, which shows a later automatic form, and not the actual gear used on 230. Normally the valve A is shut when the regulator is opened. If the slide valve of the high-pressure cylinder is in the position shown in the figure no steam can get into the cylinder at either end, and the engine fails to start. The valve A is then opened as shown in the sketch. Steam is thus admitted to the small cylinder B and the

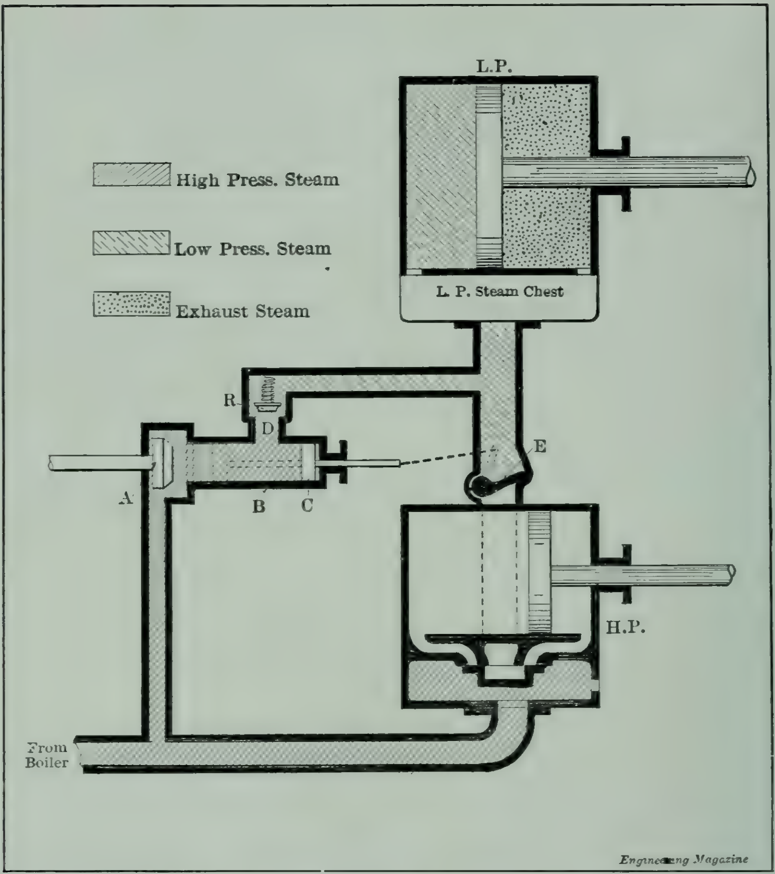


FIG. 6. DIAGRAM OF THE WORSDELL AND VON BORRIES COMPOUND LOCOMOTIVE.
The regulator and starting valves are open, and the engine is starting off the low-pressure cylinder alone.

piston C is pushed forward, thereby opening the port D and closing the intercepting valve E which is placed in the pipe which establishes communication between the exhaust port of the high-pressure cylinder and the steam chest of the low-pressure cylinder. Boiler steam makes its way through the reducing valve R by way of the port D and then flows to the low-pressure steam chest, being introduced into the supply pipe just below the intercepting valve. Directly the engine moves, steam is exhausted from the high-pressure cylinder and in its passage to the low-pressure cylinder opens the intercepting valve E, thereby pushing the piston C back to its normal (dotted) position and cutting off the boiler supply to the low-pressure pipe at the port D. The action is entirely automatic once the driver has opened the valve A. It will be understood that were it not for the intercepting valve, E, the steam introduced directly into the low-pressure supply pipe through the reducing valve R would make its way through the exhaust port of the high-pressure cylinder and appear as a back pressure on the high-pressure piston, thus trying to reverse the engine. The engine would have to start, in fact, with the reduced pressure of steam acting on the difference of areas between the low- and the high-pressure cylinders. Figure 7 shows the actual arrangement as applied to the North Eastern Railway engine shown on page 35.

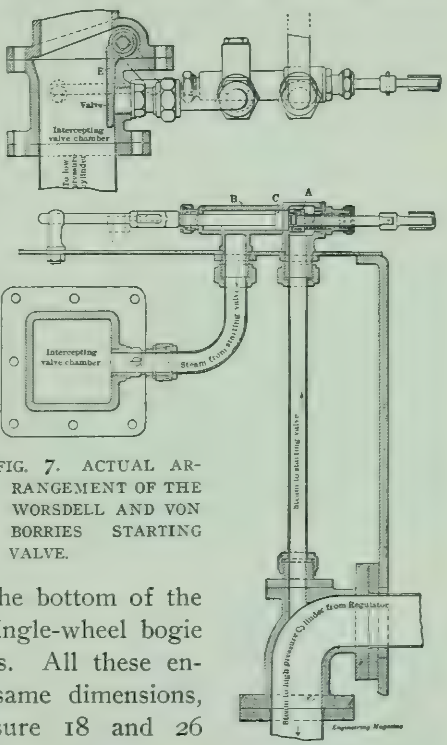
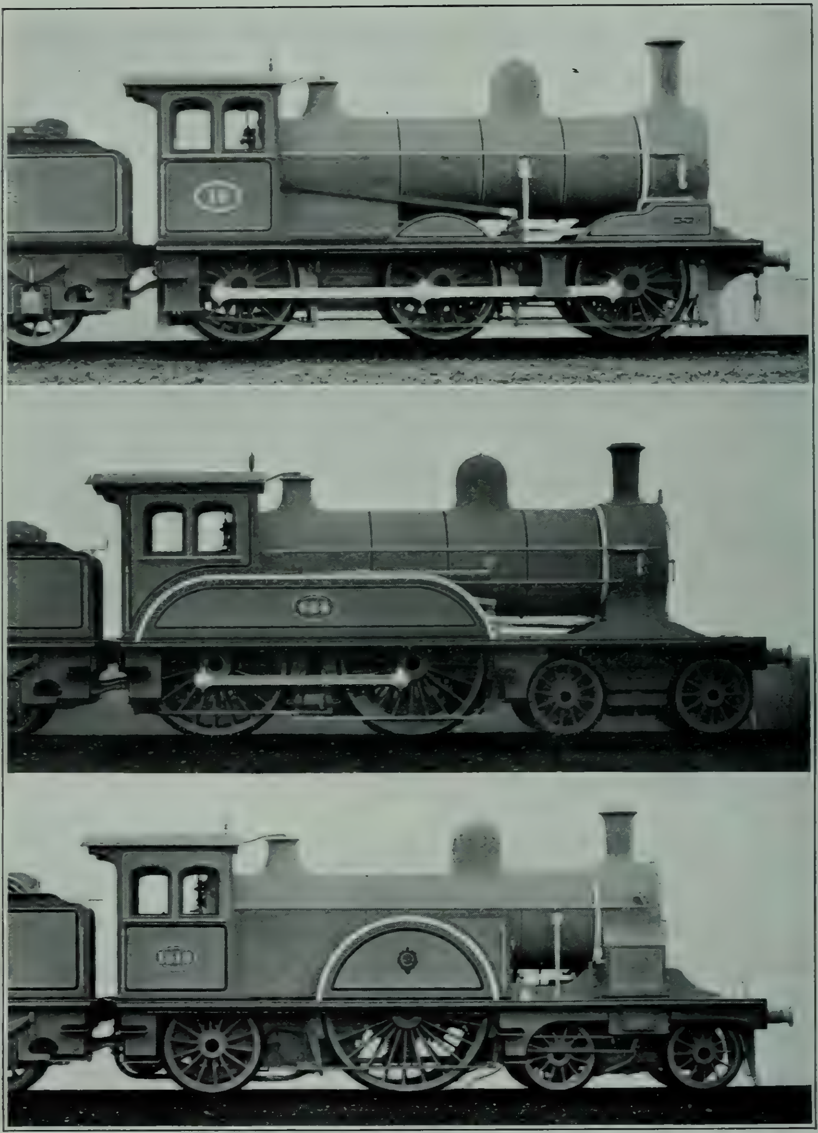

E
Valve
Intercepting valve chamber
To low pressure cylinder
B
C
A
Intercepting valve chamber
Steam from starting valve
Steam to starting valve
Steam from Regulator
Steam to high pressure cylinder
Engineering Magazine

FIG. 7. ACTUAL ARRANGEMENT OF THE WORSDELL AND VON BORRIES STARTING VALVE.

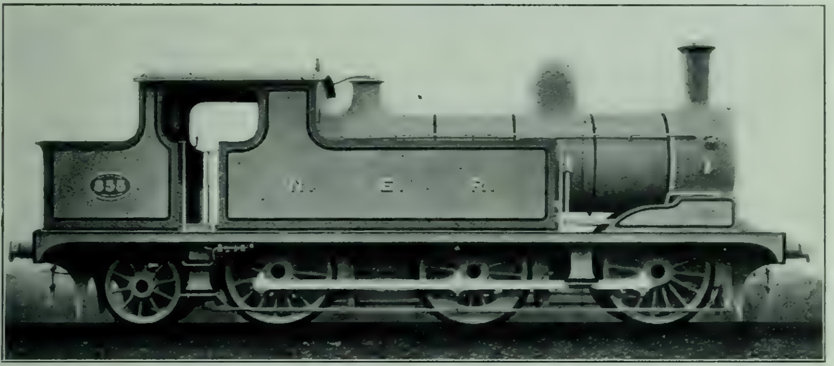
The Great Eastern express passenger engine built in 1885 was followed by nine more. In 1887 a compound goods engine was built for the North Eastern Railway. It is shown on the next page. During the period from 1887 to 1890 the system was applied to about two hundred and seventy engines on the North Eastern Railway. There were twenty-seven of the kind shown in the second illustration on the following page, ten like the engine at the bottom of the group on page 38, and ten single-wheel bogie expresses with smaller wheels. All these engines had cylinders of the same dimensions, namely high- and low-pressure 18 and 26 inches diameter respectively, both being 24 inches stroke, and boilers of practically the same size. In 1890 a larger single-wheel bogie express type appeared. The low-pressure cylinder was increased to 28 inches diameter, and the boiler was increased in size. The comparative sizes of these engines will be found in the table at the end. In addition to these passenger engines there were one hundred and seventy-one compound, six coupled goods engines, and fifty-one tank engines; a view of the latter type is given on page 39. The most recent type of compound locomotive used



EARLY TYPES OF COMPOUND LOCOMOTIVES ON THE NORTH EASTERN RAILWAY.

The uppermost is a compound goods engine of 1887; next comes a representative of a group of twenty-seven, and at the bottom one of ten. Both these types appeared between 1887 and 1890. All have cylinders 18 and 26 inches by 24 inches stroke.

in Great Britain is that patented by Mr. W. M. Smith of the North Eastern Railway. The engine is arranged for two-stage expansion through three cylinders. The first part of the expansion takes place in the high-pressure cylinder, which is placed between the frames; from this cylinder the steam is transferred to the low-pressure stage, which for convenience of working is divided between two cylinders arranged on the outside of the frames, the engine presenting the appearance of an ordinary outside-cylinder coupled engine. The three cranks operated by these cylinders are all placed on one axle, one inside and two outside, the outside cranks being coupled to a pair of trailing wheels. The two outside cranks are at right angles with each other, the inside crank being placed at 135 degrees with each of them—that is to say, the inside crank bisects the re-entrant angle formed by the two outside cranks. The method of operating the engine is extremely ingenious. The driver has it in his power to increase or decrease the pressure in the low-pressure valve chests at will within certain pre-arranged limits. Thus he may increase it almost to boiler pressure, in which case the high-pressure piston is practically in equilibrium and the engine works as a simple outside-coupled with two large cylinders and 200-pound initial steam pressure. This particular way of working is never actually used, because there is not sufficient adhesion available, but it may be approached by the driver as nearly as he pleases. On the other hand, he may reduce the pressure in the low-pressure valve chests to a certain fixed minimum, thereby reducing the back pressure on the high-pressure piston and increasing the work done by that cylinder. Further, if the expansion in the high-pressure cylinder is carried so far that the exhaust pressure falls below what is fixed as desirable in the low-



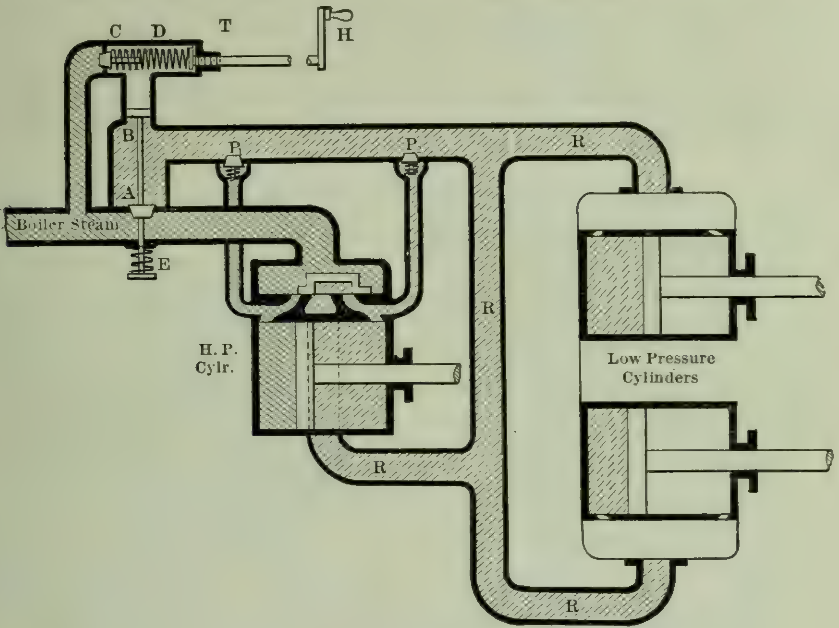
COMPOUND TANK ENGINE, NORTH EASTERN RAILWAY.

COMPOUND BUILT BY MR. S. W. JOHNSON, FOR THE MIDLAND RAILWAY.

pressure valve chests, high-pressure steam is admitted automatically to make the pressure up, this style of working being called by the inventor "semi-compound." This control of the working is obtained in the simplest way possible. The matter will be made clearer by reference to the diagrammatic representation of the engine in Figure 8. It should be understood in studying this diagram that the low-pressure cylinders are displaced from their true position; actually they are all in a line across the engine. Boiler steam is shown by the cross hatching in full lines, the steam in the space between the high- and low-pressure cylinders by the cross hatching in dotted lines. The exhaust steam from the low-pressure cylinders is not indicated at all, since it passes in the usual way into the blast pipe. It will be noticed first that boiler steam can find its way into the low-pressure cylinder supply pipe, R, R, R through the valve A. The valve itself is connected by means of a spindle to a piston valve B, the two forming a kind of double-beat valve. A second valve C will be seen above this, placed so that it controls the admission of steam to the upper

FOUR-CYLINDER COMPOUND LOCOMOTIVE, GREAT NORTHERN RAILWAY OF ENGLAND.

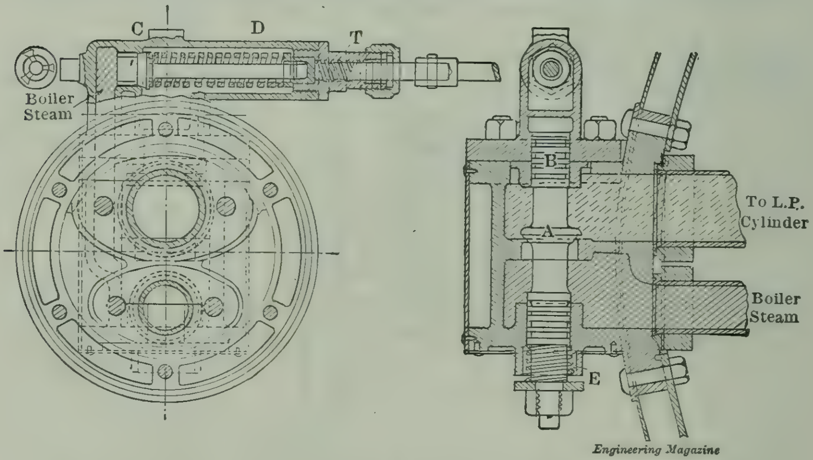
face of B. Consider first that this valve, C, is closed, or, what amounts to the same thing, that the driver by turning the handle H has compressed the spring D onto the valve so that the boiler steam cannot open it. There will be no pressure acting on B; consequently the boiler steam will lift A and pass into the low-pressure supply pipe at a pressure determined by the spring E, which may be arranged to throttle the boiler pressure down 30 or 40 pounds, say. If this spring be omitted, steam will pass in at full boiler pressure. Secondly, assume the valve C to be wide open, in which case the driver may be supposed to have turned the handle H so that the compression on the spring D is reduced to nothing. Boiler steam will then find its way into the space over B, and will exert a pressure to oppose the opening of the valve A. Assuming that the ratio of the areas of the two valves, A and B, is 2 to 1, steam will then be passed into the low-pressure space at one-half the boiler pressure. It will now be readily seen that the pressure at which steam is passed by the valve A into the low-pressure pipes can be varied between the minimum fixed by the area of B, with C open, and the maximum fixed by the strength of E with C closed; and that this control is obtained by merely adjust-



Engineering Magazine

FIG. 8. DIAGRAM OF CYLINDERS FOR MR. W. M. SMITH'S COMPOUND LOCOMOTIVE.

ing the compression of the spring D, which the driver can do at any moment from the cab. For a given compression of the spring D the action of A is entirely automatic. A gauge in the cab gives the pressure of the low-pressure supply, and this pressure is maintained by the automatic action of the valve A, providing, of course, sufficient steam is forthcoming from the boiler. There is a third important part of the arrangement to consider. Suppose the high-pressure valve at starting happens to cover both the steam ports so that no steam can get into the high-pressure cylinder at either end. Steam will pass A at a reduced pressure, and the engine will thus be able to start with the low-pressure cylinders alone; but unless special provision is made this steam will also tend to reverse the high-pressure engine, because it has free access to one face of the high-pressure piston, the other (in the position of the valve assumed) sustaining only atmospheric pressure. This difficulty is got over by putting the steam ports in communication with the low-pressure supply pipes through the non-return valves P_1 and P_2. In this way the high-pressure piston is thrown into equilibrium, because whatever pressure acts on the face of the piston in communication through the exhaust port with the low-pressure supply, an equal pressure is brought to bear upon the other face through steam passing one or other of the valves P. If the steam in the low-pressure supply pipes ever reaches the boiler pressure, the effect of the valves, P_1, P_2, is to keep the high-pressure piston working in a state of equilibrium, the engine being therefore a simple one.



Engineering Magazine

FIGS. 9 AND 10. ACTUAL FORM OF MR. W. M. SMITH'S REDUCING VALVE.

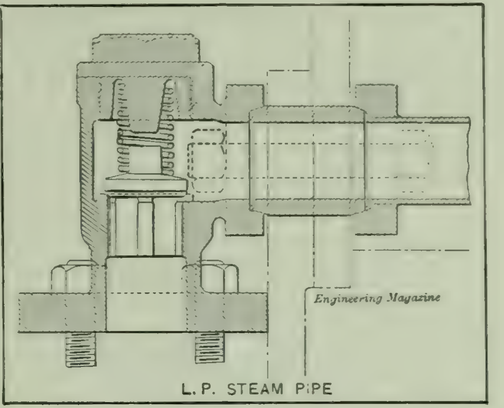


FIG. 11. NON-RETURN VALVE, NORTH EASTERN RAILWAY COMPOUNDS.

The actual form taken by the reducing valve, A and B, is shown in Figures 9 and 10, which are lettered similarly to the diagram. Figure 11 also shows one of the non-return valves, P. Figure 12 shows a valve which is placed on the steam chest of the high-pressure cylinder for destroying the vacuum in the cylinder when the engine is running with steam shut off. Directly the pressure falls below that of the atmosphere the large valve A lifts, its lower face being acted upon by the atmosphere, and in lifting opens the small steam valve B. Steam rushes through the conical orifice C, and air and steam together destroy the vacuum which otherwise would have been destroyed by drawing air and gases loaded with grit down the blast pipe through the exhaust passages of the valves.

The diagram shows a valve of the ordinary type in connection with the high-pressure cylinder. It should however be stated that a piston valve is used for the high-pressure cylinder in the actual engine. This piston valve is of a type invented by Mr. Smith, the object of its special form being to allow trapped water to get away through the valve in the way it passes the ordinary slide valve. Briefly, the valve is a piston valve in form, but the usual packing rings, assuming one broad one at each end, are cut into three separate portions, each portion actually forming a small slide valve, being

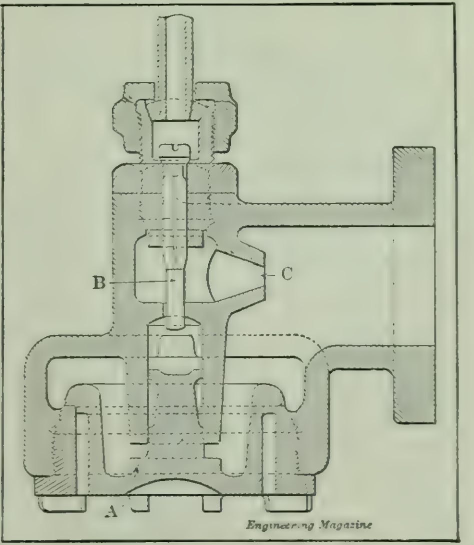


FIG. 12. VALVES FOR DESTROYING CYLINDER VACUUM, NORTH EASTERN COMPOUNDS.

TABLE I.

Designation.	Diameter of Driving Wheels.	Total Weight on Driving Wheels in Tons.	Boiler Pressure.	Vol. of H. P. Cylrs.	Vol. of L. P. Cylrs.	Ratio, Vol. L. P. Vol. H. P.	Total Heating Surface, Sq. Ft.	Grate Area, Sq. Ft.	Ratio, Heating Surface—Grate Area.	Cylinders.	
				Cu. Ft.	Cu. Ft.					H. P.	L. P.
Experiment, 1882	6 ft. 6 in.	....	...	2.88	7.6	2.64	1083.5	17.1	63.	11½ by 24	26 by 24
Experiment class, 1883....	6 ft. 6 in.	27.8	150	3.68	7.6	2.06	1083.5	17.1	63.	13 by 24	26 by 24
Dreadnought class, 1884...	6 ft. 0 in.	30.0	175	4.28	9.8	2.29	1401.5	20.5	68.3	14 by 24	30 by 24
Teutonic class, 1889.......	7 ft. 0 in.	31.0	175	4.28	9.8	2.29	1401.5	20.5	68.3	14 by 24	30 by 24
Greater Britain class, 1891.	7 ft. 0 in.	....	175	4.92	9.8	1.99	1540.9	20.5	75.	15 by 24	30 by 24
8-coupled goods class, 1893.	4 ft. 3 in.	....	175	4.92	9.8	1.99	1489.0	20.5	72.	15 by 24	30 by 24
John Hicks class..........	6 ft. 3 in.	....	...	4.92	9.8	1.99	......	....	....	15 by 24	30 by 24
Black Prince class, 1897...	7 ft. 1 in.	34.2	200	4.92	8.94	1.82	1400.	20.5	68.3	15 by 24	20½ by 24
6-coupled goods class, 1903.	5 ft. 0 in.	44.0	200	4.92	8.94	1.82	1753.	20.5	85.5	15 by 24	20½ by 24
G. E. R. Express, Passr., 4-cyl., 1885	7 ft. 0 in.	29.7	160	3.53	7.38	2.09	1200.	17.3	69.4	18 by 24	26 by 24
N. E. R. Goods, 6-coupled, 1887	5 ft. 0 in.	41.85	160	3.53	7.38	2.09	1136.	17.23	66.	18 by 24	26 by 24
N. E. R., 4-coupled express, 1887	6 ft. 8 in.	30.5	170	3.53	7.38	2.09	1323.	17.33	76.4	18 by 24	26 by 24
N. E. R., 4-coupled bogie express, 1888	6 ft. 8 in.	30.5	170	3.53	7.38	2.09	1323.	17.33	76.4	18 by 24	26 by 24
N. E. R., bogie, single, 1889.	7 ft. 0 in.	18.0	175	3.53	7.38	2.09	1136.	17.23	66.	18 by 24	26 by 24
N. E. R., bogie, single, 1890.	7 ft. 6 in.	17.75	175	3.53	8.55	2.42	1139.	2.07	55.	18 by 24	28 by 24
N. E. R., (1619), 1899....	7 ft. 0 in.	....	...	4.27	8.72	2.04	1324.	23.0	57.6	19 by 26	20 by 24
M. Ry., (2631 and 2), 1902	7 ft. 0 in.	38.8	195	4.27	10.04	2.34	1598.†	26.0	61.5‡	19 by 26	21 by 26

† With serve tubes, 1720. ‡ With serve tubes, 66.2.

pressed onto the cylinder face of the ports by the steam pressure, and being free to fall away a short distance under the pressure of trapped water. A special exhaust ring prevents steam passing from the pressure to the exhaust side of the valve. By this arrangement the actual area of sliding surface is considerably reduced, and it has been stated that the wear of these segmental valves is only one-eighth of the wear of a slide valve of the usual type.

This system was first applied when Mr. Wilson of the North Eastern Railway rebuilt engine No. 1619, in 1898. A photograph of the engine in its rebuilt form was shown last month.* To increase the steaming capacity of the boiler, cross tubes were applied through the firebox. The engine has done exceedingly good work and at the present time is working, unassisted, the heaviest and fastest trains between York and Edinburgh.

Mr. Samuel Johnson built two engines of this type for the Midland Railway and one of these is shown on page 40. They have been running since August, 1902, between Leeds and Carlisle, working the fast expresses. This section of the road includes gradients of 1 in 100, 15 miles long. Full particulars of the fine performance of engine No. 2631 will be found in *Engineering,* Feb. 6 and March 27, 1903. Mr. S. W. Johnson has just completed the fifth engine of this type.

The table on the opposite page brings together the principal dimensions of the engines which have been illustrated and discussed.

An examination of the figures in the table will show that considering the London and North Western engines from the Dreadnought class down to the latest type given, the grate area is the same, namely 20.5 square feet; and that with the exception of the last on the list, the North Eastern engines have all practically 17.3 square feet of grate. The recent Midland engines have, however, 26 square feet of grate area. Assuming that all these engines alike burn as a maximum 100 pounds of coal per square foot of grate per hour when taking their full loads at express speed, and that the calorific power of the coal is 13,000 British thermal units, it follows that the maximum amount of heat developed in the firebox per second in the several cases is:

N. E. R. compounds	6,240 B. T. U. per second
L. & N. W. compounds	7,400 " " " " "
Midland compounds	9,380 " " " " "

The maximum steady horse power of the engine will depend upon the proportion of these quantities which can be utilised as work in the cylinders. It may be fairly assumed that the boiler efficiency in each case is 70 per cent., so that the quantity delivered to the cylinders by the steam pipe will be:

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*The Engineering Magazine, September, 1904, page 953.

N. E. R. compounds	4,370
L. N. W. compounds	5,180
Midland compounds	6,560

To estimate the horse power from these figures we must know:

(1) The theoretical engine efficiency,
(2) The efficiency ratio.

Applying the standard adopted by the Institution of Civil Engineers to find (1), the efficiency is computed from the expression

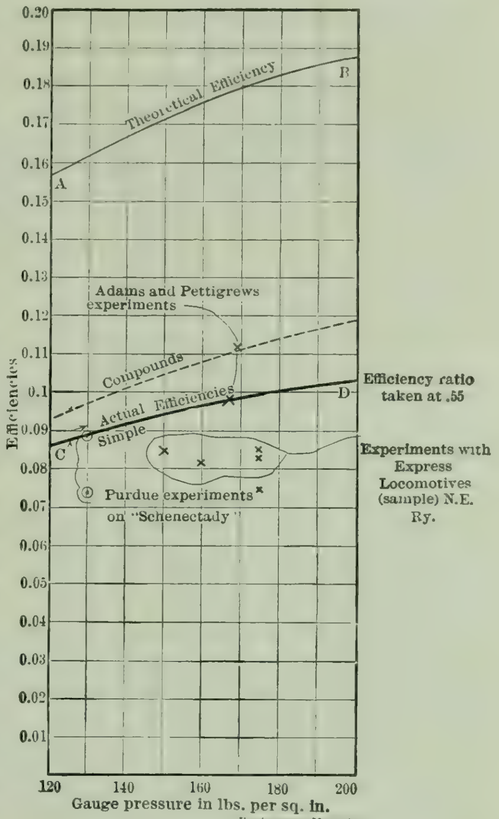
$$\text{Efficiency} = \frac{(T_1 - T_2)\left(1 + \frac{L_1}{T_1}\right) - T_2 \log e \frac{T_1}{T_2}}{L_1 + (T_1 - T_2)}$$

where T_1 = the absolute temperature of the steam corresponding to the initial absolute pressure.

T_2 = the absolute temperature of exhaust, taken at 673 degrees (212 degrees F.)

L_1 = latent heat of the steam at temperature T_1.

Figure 13 shows a curve from which the theoretical efficiency can be taken and which was plotted from the above formula. The curve shows how the efficiency increases as the temperature of the steam is increased. To find (2) is not an easy matter. The crosses on the diagram show the efficiency as obtained in Messrs. Adams' and Pettigrews' experiments on the London and South Western Railway with an express locomotive. The dots show the efficiencies obtained in Prof. Goss' experiments with the simple engine Schenectady at Purdue. The highest dot and the lowest cross each indicate an efficiency ratio of about .55. Drawing the line CD therefore so that it cuts off .55 of the vertical distance between the base and the theoretical efficiency line AB, the maximum horse power may now be computed. Judging by the results stated to have been obtained with compound locomotives, the saving with 200-pounds pressure may be taken at 15 per cent. It is unlikely that the saving would be more than half this at 120 pounds per square inch. Taking these two values and sketching in the dotted curve, it may fairly be assumed that it represents the efficiencies of compound engines for pressures between 120 and 200 pounds per square inch. This curve is, of course, only an assumed one. But in the first place CD may be taken to represent what a simple engine should do in the best circumstances, because the efficiencies have been realised in practice. The compound curve should therefore certainly be above this.



Engineering Magazine

FIG. 13. THEORETICAL AND EXPERIMENTAL EFFICIENCIES OF COMPOUND LOCOMOTIVES.

Considering now the case of the Black Prince type, where the pressure is 200 pounds per square inch (215 absolute) the proportion of the heat supplied which can be turned into useful work is, reading the efficiency from the curve, 0.118, that is, 611 B. T. U. per second, which corresponds (dividing by 0.71 the B. T. Units per second corresponding to one horse power) to 860 indicated horse power. The corresponding horse power of the Dreadnought class with an efficiency of 0.113 is 824, not greatly less than the Black Prince class. In the North Eastern engines it will be seen that the initial pressure varies from 160 to 175 pounds per square inch, corresponding to efficiencies of 0.108 and 0.113. In the case of the engines with the lower pressure the maximum horse power is 664, increasing to 696 with the higher pressure. The Midland engine has an efficiency of 0.117, consequently the maximum horse power would be about 1,090. These figures are, of course, merely comparative, and represent steady conditions of running with uniform boiler pressure; but they serve to show how locomotives may be compared with one another in a thermodynamic sense and to mark out with reasonable accuracy the upper limits of the horse power which may be expected under the fuel consumption assumed.

A study of these curves and the examples worked out will show how much more effectively an increase of grate area increases the power of the engine than an increase of pressure, even when that increase is accompanied by compounding. The maximum horse power which may reasonably be expected from a given engine may be calculated from the following formula, which only represents the process used to obtain the horse power in the above illustrations,

$$\text{I H P} = \frac{Q\,A\,C\,\beta\,\eta}{2545}$$

in which

Q = coal burnt per square foot of grate area per hour,
A = grate area in square feet,
C = calorific value of the fuel in British thermal units,
β = boiler efficiency,
η = engine efficiency.

In the series of experiments with express locomotives carried out on the N. E. R. R. β had an average value of 0.63 nearly, and η as indicated on Figure 13, had an average value of 0.081. The result of five experiments on an express locomotive by Messrs. Adams & Pettigrew gave values 0.72 and 0.1 for β and η respectively. The difficulty in making complete thermodynamic tests of a locomotive on the road is exceedingly great, because all the factors of the test are continuously varying. The records of the coal consumption per mile afford a direct and valuable way of comparing the performance of a set of locomotives employed on the same service, but the records of engines on different services cannot be compared.

It is to be regretted that there is no locomotive-testing plant in England where the actual performance of a locomotive may be measured in a way to obtain the number of heat units per indicated and per draw-bar horse power. The United States is to be congratulated in the possession of more than one establishment of the kind, and at the present time the focus of scientific research on locomotive economy is undoubtedly situated at Purdue University.

My acknowledgements are due to Mr. George Whale, of the London and North Western Railway; Mr. Wilson Worsdell, of the North Eastern Railway, and Mr. Smith, for kindly sending me the photographs from which the views illustrating this article have been prepared.

THE INTRODUCTION OF HIGH-SPEED STEEL INTO A FACTORY.

By A. D. Wilt, Jr.

There have been few modern developments of machine-shop practice—if any—which offered such economies and required such changes in equipment and methods as the new air-hardening steels. The great interest of Mr. Wilt's articles is his direct attack upon the practical aspects of the introduction of high-speed steel, and his definite plans for meeting all the problems, both mechanical and managerial.—The Editors.

A PRECEDING article reviewed the specific mechanical problems attending the replacement of carbon-steel by high-speed steel—especially the methods to be followed in hardening small tools, made of the newer material, for the various classes of machines in the shop, the apparatus and temperatures to be employed, and finally the changes in the machine tools themselves necessitated by the higher duty demanded of them. It remains to take up certain questions more general but yet more fundamental—the problems of management, wages, and costs, which are radically changed by the change in rate of production effected by the high-speed steels. In other words, taking into account not only the mechanical but also the human factors:—

III. What Is the Best Plan for Introducing High-Speed Steel into a Factory?—

Many new processes and machines lately brought forward have involved changes in piece-work prices, speeds, feeds, machinery, etc., but few have involved such a general and extensive change as high-speed steel. For this reason it requires most careful consideration in order to secure highest efficiency. In the first place it is impossible to know just what increase in production is possible and practical without systematic experimenting. A manufacturer might know in a general way what results should be obtained, from what other factories have obtained.

Just what should be accomplished in any one factory without an exhaustive try-out by competent men cannot be predicted. This steel must be adapted to conditions as they exist in each factory, and it is obvious that to attain the highest efficiency this adaptation must be made in a thorough manner and not by guess-work. The only thorough manner is for a capable man to actually run the machine under working conditions with high-speed-steel tools as well as carbon-steel tools, and to obtain results from comparison.

It is a custom in some factories for the foremen to try out the jobs. They do this in some cases by actually running the machine, and in other cases by simply watching the workman run the machine. Some foremen can set a fair price in the latter way when they have had long experience with carbon-steel tools, but when any foreman attempts to set a price in this manner using high-speed steel, he cannot for some time tell anything about it. He must actually run the machine, and even if he does so he cannot tell at first what should be accomplished. He must learn by experience. Since the speed at which tools must be run to attain the highest efficiency varies with each job, the best results cannot be obtained without a try-out of each one.

As some factories have as many as 25,000 or 30,000 different piece-work prices it is impossible that each of these be tried out for any length of time. It is possible and practical, however, that enough prices be tried out on each different machine and class of part to enable an understanding of what prices should be set for similar jobs which are not of enough magnitude for an extensive try-out.

This leads to the necessity of keeping certain data for consultation. It is evident that a skilled man running a machine for a time could obtain some valuable data, relating not only to piece-work prices, but to the conditions under which each machine should be run to attain the highest efficiency. He might discover that one machine is not so well adapted as another to turning out a certain part, or he might find that a heavier machine would greatly increase the output. Why not combine his experience with that of half-a-dozen other men?

This can be accomplished if the responsibility for the proper introduction of the steel be fixed on a certain number of men—the necessary number depending on local conditions, such as the number of employees and different types of machines in use.

A method employed with great success in several shops with which I have had experience is to establish a high-speed-steel committee, which is responsible for all changes in tools, machinery, piece-work prices, etc., incurred by the adoption of high-speed steel. The members of this committee run actual try-outs, or tests, on all machines in the shop. They do not entrust the securing of such valuable data to the workmen, but operate each machine under working conditions. Each member acquires data, which are submitted to the committee as a whole for conjoined consideration.

This committee should not only study the question by a comparison of observations made among its members, but should be instructed by men from the outside, experts on high-speed steel, who could tell its members what other factories have done in regard to increasing output, regulating costs, etc. The personnel of such a committee would necessarily depend upon conditions in each shop. If it were a union shop its members obviously could not be union men, and foremen or assistant foremen would have to be employed. If it were a non-union shop the best results could be obtained from foremen or assistant foremen or expert mechanics. In factories operating three or four types of machines, better results could be obtained by having one or two men from each department on the committee.

In fact, the general questions proposed in this article can only be answered after a thorough try-out of both carbon and high-speed steel by competent men, and a careful comparison of the data obtained from such a try-out. The object of such a try-out—the object of using high-speed steel—is chiefly to increase the output, which depends on the following factors.

A.—The tool.
  1. Its construction.
  2. Its composition.
  3. The amount of material it must remove.
  4. The hardness of the metal on which it must operate.
  5. The finish required on the part.
  6. The use or not of a cooling agent.
  7. The cutting pressure on the tool.
  8. The time it should last.
  9. The number of tools to use simultaneously.

B.—The machine.
  1. The speed combination to give at the same time the propei cutting speed and pressure required to take the cut.
  2. The stiffness of the work.
  3. Its fixtures, such as jigs, chucks, automatic magazine feeds, etc.

C.—The workman operating the machine.
  1. His relations with his employer.
  2. His desire to better his condition.
  3. The stability of his employment.
  4. The piece or day-rate system employed.

At the time of the introduction of high-speed steel, the tool and the part are immediately affected and become variables; the machine

Tool No.	Steel (brand)	TOOL CARD	Hardened by (Check No.)	Date

Temp. of furnace (°F)	Heat (Color)	Drawn to (°F)	Dept. (Drill, etc.)

Cooling agent (air, oil, etc.)
Type of Furnace (Cylindrical gas, etc.)
Remarks (By Blacksmith)

Name of part	No. of parts operated on	Check No. of Operator	Machine No.	Speed r.p.m.	Feed ft. per min.	Stock removed (Cubic amt.)	No. times ground	Remarks

Detachable.

Remarks: (By High Speed Steel Committeeman)

FIG. 1. "TOOL-CARD," FOR COLLECTING DATA CONCERNING THE USE OF HIGH-SPEED STEEL.

and the man operating it may or may not be ultimately changed, so they can be considered as constants. It is only necessary to keep data concerning the variables and their relations to the constants. Figures 1 and 2, which may be called the Tool and the Part Cards, respectively, give general data which should be of great value if properly obtained and interpreted.

The Tool Card should be attached to every new tool immediately after its completion, and should accompany it until it is worn out and ready to be sent to the committee for examination.

Part & Order No.	PART CARD	Dept.

Box Numbers	Lot No.	Part Name
Operation name & No.		
Workman's Check No.	Machine No.	Quantity operated on
Date	Rate per 100	Time per 100
Fixtures used		

Tool No.	Description (brand, etc.)
Carbon ground every	
High Speed ground every	

Finish	Gauge used	Speed r. p. m.	Feed ft. per min.	Cone feed	Lubricant

Depth of cut	Trial No.
Breadth	Name of operator
Width	
Length	Signed H. S. S. Committee
Cubic amt.	

Piece Rate Pricing		Actual working time per lot	
Trial by		Allow for setting up per lot	
No. pieces machined		Allow for per lot	
Actual working time required		Total time required per lot	
Basis rate per hour		Pieces per hr. including allowances	
Machined in lots of		Piece rate (per 100) should be	

(Detachable)

Remarks:-

(Recommendations of High Speed Steel Committeeman as to the adaptability of a part to a machine, etc.)

Signed: (H. S. S Committee)

FIG. 2. "PART CARD," FOR COLLECTING DATA CONCERNING THE USE OF HIGH-SPEED STEEL.

No record is necessary of the construction of the tool except its cost and production. As this is kept in most cases by the system in vogue in any factory it is needless to provide a new one for it. For this reason, the plan proposed is applicable to any factory, whether it makes its own tools or buys them ready made. A number should be stamped on each tool either by the tool-maker or the blacksmith, and letters indicating its brand of steel. Some tool rooms turn out a number of similar tools in a lot. It is essential, no matter how many are turned out at a time, to keep an individual card with each one. The moment

Part & Order No.	INSTRUCTION CARD	Dept.

Box Numbers Part Name
Operation name & number
Fixtures to use
Machine to use

Finish	Gauge	Speed of tool r.p.m.	Feed ft. per min.	Cone feed	Lubricant

Output per hour including allowances
Grind tool

Signed:

FIG. 3. INSTRUCTION CARD. TO ACCOMPANY PARTS TO EACH NEW OPERATION WITH HIGH-SPEED STEEL TOOLS.

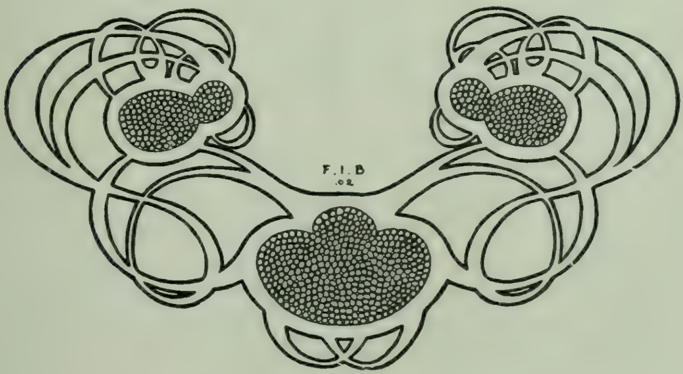
accuracy is overlooked the results become guess-work and are worth nothing.

As soon as another tool of the same kind comes in for hardening the blacksmith should heat it not so hot as, or hotter than, the tool previously hardened. After he has hardened a few tools thus he will be able, by comparison and by consulting the record cards of the life of these tools, to find the best conditions of hardening them.

The Part Card is necessary only when a try-out is to be made and should be placed with the parts as they are charged out to each operation. The next problem after acquiring the data on cards 1 and 2 is to use it most efficiently. The workman and the blacksmith must be instructed by the committee. The Tool Card gives ample information for the blacksmith, and should be sent to him with the worn-out tool after it has been compared with the Part Cards by the committee. The foremen and the workmen must also be instructed. The method of doing this is simply a reversion of the data-acquiring process. In this the Part Card has reached the high-speed-steel committeeman, i. e., the "try-out man," in a blank form. After it has been filled out by him, certain data from it and from the Tool Card should be placed on a card which should accompany the part each time it is charged out to an operation. This card might be called the Instruction Card, and contain data such as shown in Figure 3. Such a card is now used in many factories. It should be attached to the piece-work or day-work tickets that customarily accompany a part to each operator. This should be done repeatedly until a new try-out is deemed necessary. The responsibility is fixed in this case, and the workman has no excuse for spoiling a part or tool, or racking a machine by a too rapid speed, and he has a mark set without guess-work which is an index as to what should be his output. Such an instruction card is in fact an insurance to both employee and employer.

The average factory employee who has had much experience with systems of any kind has generally a horror of them. It is no wonder that this is the case in many factories which are literally buried under systems—for this is an era of systems. On the face of it, the task of keeping track of all tools and parts as proposed here might seem too great to pay for the results. As a matter of fact, it takes so long to make new tools that the introduction of high-speed steel is by necessity a comparatively slow process, and a few men should have no difficulty, if try-outs last no longer than an hour, in keeping pace with the output of the tool room of the average factory.

As no process discovered in recent years has effected such an increase of manufacturing capacity and such a general revolution in machine design, as high-speed steel, it is by necessity worthy of most careful study by the wide-awake manufacturer, who cannot fail to see the advantages of fixing the responsibilities of its introduction into the factory upon a carefully selected body of trained men.



HIGH-SPEED ELECTRIC INTERURBAN SYSTEMS FOR FREIGHT AND PASSENGERS.

By Ralph Scott.

The functions of electric traction, with reference to steam, appear to be generally of two kinds:—first, under certain somewhat limited conditions, to replace the locomotive in handling existing traffic; second, to build up a different kind of transport service, for which steam is not adapted. The systems described by Mr. Scott in the following article exhibit, in part, both these characteristics, and are interesting examples of a vast possible development.—THE EDITORS.

AT the present time, there are in successful operation in the anthracite coal region of Pennsylvania, two similar systems of electric railways which are built in accordance with the best modern steam-railroad practice, and which are conspicuous examples of the adaptability of electric roads for high-speed freight and passenger service. These systems are the Wilkes-Barre and Hazleton Railway, connecting Wilkes-Barre and Hazleton, and the Lackawanna and Wyoming Valley Railroad, connecting Wilkes-Barre and Scranton, with an extension to Carbondale.

On account of the difficult engineering problems which have been encountered, and their successful solution, these roads will, it seems safe to say, establish a precedent for the installation of a number of similar systems. The series alternating railway motor may also owe its first extensive application to one of these roads. A continuation of the principles which these roads have adopted would cause an epoch of heavy electrical railroading that would cause all the electrical work that has been done up to the present time to pale into utter insignificance.

It has been shown that a double-track third-rail system possesses great economic, flexible, and accelerative transportation facilities. The daily performance of these roads has shown also that small freight-carrying units, operating at high speed, are not subject to many of the limitations to which steam roads (even when equipped with up-to-date signal systems and other means for safe and rapid locomotion) are liable. Among the principal of these limitations may be mentioned:—

1.—The extra work necessary in shifting cars which are destined for various stations, and the delay consequent on classifying according to destination.

2.—Cumbersome methods employed in the handling of large amounts of freight.

3.—Frequent repairs to the track and rolling stock necessitated by the wear and tear on both by the movement, coupling, and shifting of heavy trains.

4.—Liability of a small breakdown delaying or destroying an entire train.

5.—Impracticability of moving long trains at high speeds.

6.—Increased weight of rolling stock, massive construction being necessary to minimize probability of breakdown while shifting cars and starting up long trains.

7.—Relatively low economy resultant on using a number of steam-generating units, each having a questionable efficiency.

Early electric-railway systems, and in fact recent electric yard locomotives, with but few exceptions, contemplated the concentration of the motive power in a single unit. These installations applied directly the practice common in steam locomotion, namely, the employment of a dummy with the requisite power, without consideration of the fact that the latter not only translated the heat energy of the steam into motive power, but also generated it. The means employed in the process of generation and translation, also, fortunately, gave the necessary weight to produce a ratio of adhesion which was consistent with the tractive effort. However, on account of the small weight of the electric motor per unit of tractive effort, after giving the proper speed reduction, the ratio of adhesion was entirely too low to be practicable. Hence the necessity of additional dead weight to give the electric dummy the required adhesion ratio for the hauling of a weight which would meet the requirements of economy.

The use of a relatively small number of units capable of developing a heavy torque, whether the motive power be electricity or steam, is advantageous from many points of view. The first cost of motor-driven freight units, if their number be sufficient to carry all the freight of an ordinary steam road, would be very great. By using the locomotive principle, with either steam or electric units, and hauling the heaviest freight in long trains, at times when the passenger traffic is least—that is, during the night—the cost of freight transportation is reduced to a minimum. Both of these roads have adopted this practice, the greater part of the heaviest freight being hauled dur-

TWO VIEWS ON THE LINE OF THE WILKES-BARRE & HAZLETON ELECTRIC RAILWAY.
The upper one is "Walp's Farm" fill; the lower is in the Conyngham Mountains.

ing the night by steam locomotives. An increase in freight traffic would so multiply the number of steam units that the most feasible and economical solution would be the employment of electrically-driven units.

A successful system of heavy railroading signifies the fulfilment of a number of specific conditions. Among these conditions are:—

economy and reliability of operation; a simple and reliable controlling system; high torque; and good speed acceleration of the motive elements. The low starting torque of the steam locomotive is well-known. If the cut-off be increased to maintain as nearly as possible a uniformly high mean effective pressure it is found impossible to keep the firebox contents in their proper condition, on account of the vacuum produced by the exhaust. The high factor of depreciation of powerful locomotives also militates against an increase in average output beyond a certain critical point. Improvements have been sought after along the lines of high piston speed, high boiler pressure, and multiple expansion, all of which are achieved with a high factor of depreciation and repairs due to the multiplicity of parts; and many railroad managers are conversant with the fact that the recent advances in the size and output have not been warranted by any resuitant economy.

The construction of present steam-road freight-carrying units precludes the application of motors to each; hence, an entirely distinct set of cars is necessary for use as multiple freight-carrying units.

The fact that there is equal economy in freight transportation on both steam and electric roads would not conclusively argue for the general adoption of the latter system, nor would such a deduction form a basis for the subsequent universal relegation or revision of engineering tactics which would cause existing steam roads to assume a state of decrepitude; but the fact that the overwhelming advantages of electric traction, as utilized by these roads, are apparent from every side, renders such a conclusion self-evident.

Long trains, which are advantageous from a protective and time-interval standpoint, may, by the adoption of the multiple-unit system of control, be readily moved expeditiously, since the same power is taken by each car in the train as would be taken were it operating independently. The tractive effort, as a whole, is thus increased with an increase in train length, the only limitation to the number of cars employed being the current which the third rail is capable of delivering without excessive drop or line loss.

As stated before, it is not incumbent to use exclusively electrically-driven units in such a system. Locomotives are as applicable to train movement as are the motor-driven units—in fact, both may operate simultaneously. A breakdown in the generating or translating equipment in such a system (although of but remote possibility, yet worthy of consideration), does not assume the important phase that such a state of affairs would cause were the electric system alone used. It is only by coincident operation, on a basis of equal advantage, that the relative adaptability of steam or electrically-driven or hauled conveyances to transportation can be ascertained. A direct line of argument, of adequate parallel, is thus assured for the exponents of each system.

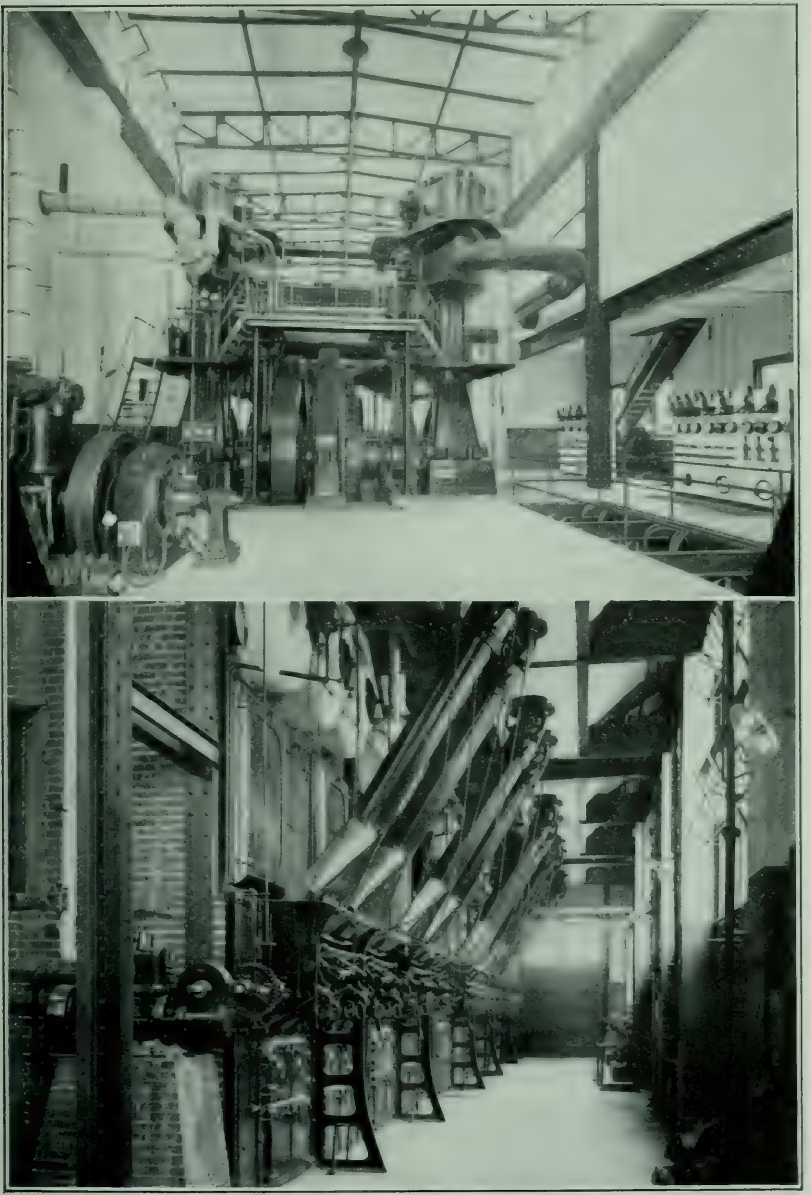
Both roads of which this article deals have the very highest standard of excellence in equipment and construction, and are equally capable of handling an enormous volume of business. Being interurban, they are able not only to handle the business between the cities which they connect, but are also the means of inciting and directing otherwise inactive suburban business into a profitable channel. The extension of such roads, using rural combination freight and passenger stations for concentrating purposes, will provide an outlet for an enormous amount of traffic that could in no other way be accomplished.

The ease of starting and stopping a motor-driven car renders possible a high average speed, even with frequent stops. Such cannot be said of local steam trains, on account of the great loss of time incident on such stops.

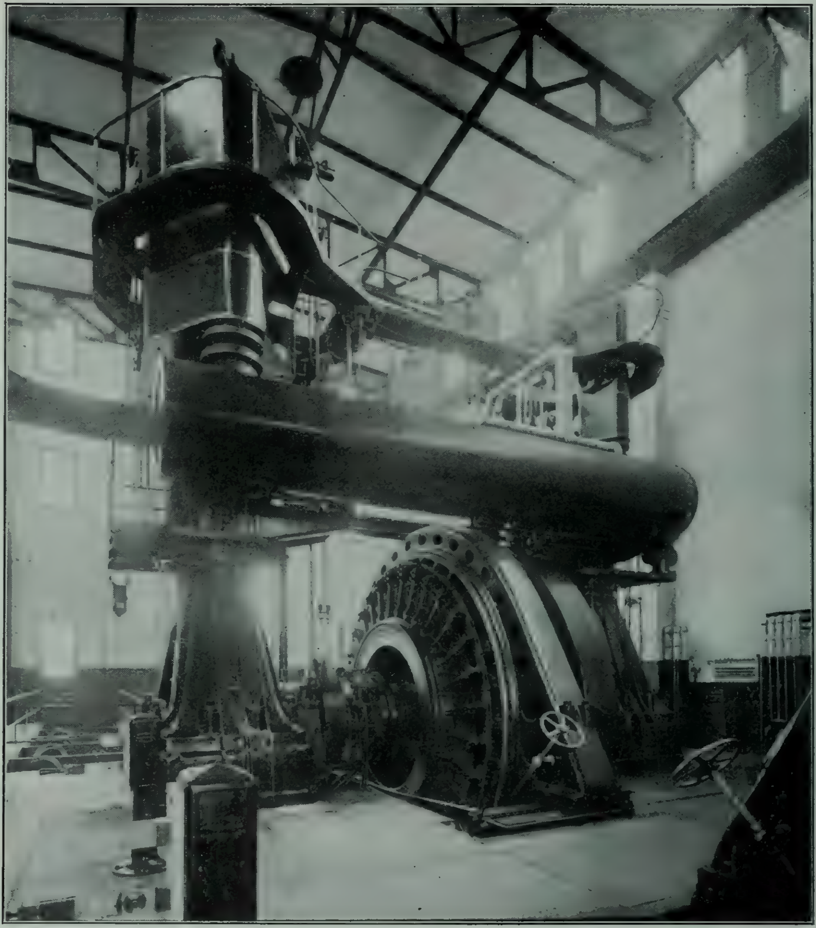
Where the freight and passenger service is uniform, it is advantageous to combine both freight and passenger cars in single units. This plan has been adopted by both roads, and their experience has shown it to be the most practical solution. The passenger compartment, which is separated from the freight compartment, is capable of seating forty or fifty persons without crowding. In the freight compartment are adjustable seats for about twelve persons, these seats being out of the way when freight only is carried. The latter part is 12 feet 9 inches long, and is provided with sliding doors for convenience in handling the freight.

The terminal facilities of these roads are on an equal basis with up-to-date steam railroads. Express service on the latter is no quicker than ordinary freight carrying on the electric system, because of the fact that on these roads all merchandise is handled without classification as to the time consumed in transportation. Thus 100 bushels of apples would be carried with no greater consumption of time in transit than would be required for a book of poems. The following is a brief description of the Lackawanna and Wyoming Valley R. R.:

The right of way includes about 40 miles of double-track railway. The road from Scranton to Carbondale is about 17 miles long, from Scranton to Wilkes-Barre 19 miles, with a proposed extension to Nanticoke of about 8 miles, which is to be completed in the near future. The power house, situated at Scranton, is of rectangular form, 90



ENGINE AND BOILER ROOMS, POWER PLANT OF THE LACKAWANNA & WYOMING VALLEY RAILROAD.



ONE OF THE GENERATING UNITS, POWER HOUSE OF THE LACKAWANNA & WYOMING VALLEY RAILROAD.

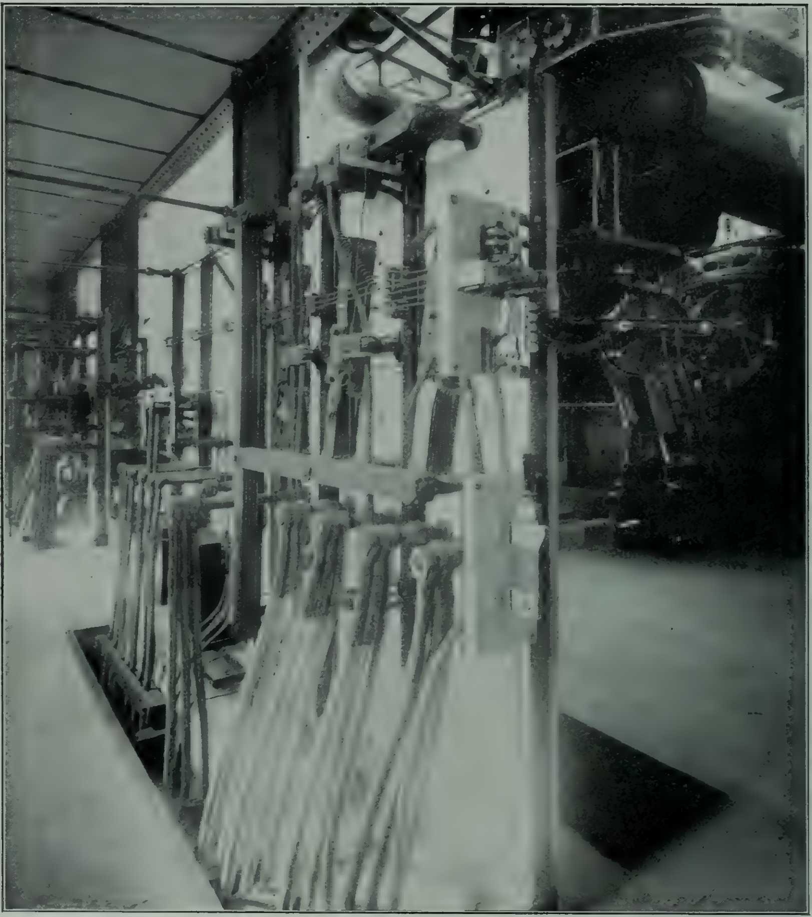
feet by 134 feet, the central part, above the generating units, being 42 feet high. The boiler room is separated from the engine room by a thick brick wall, being 42 feet wide and 26½ feet high. Installed within the boiler room are five Babcock & Wilcox boilers of the water-tube type, the normal capacity of each being 400 horse power, and each being capable of being forced to 600 horse power continuously. The working pressure is 160 pounds. These boilers are supplied with coal by Roney mechanical stokers, driven by a small Westinghouse standard engine. The stokers are fed from a coal bunker placed above and in front of the boilers, this bunker being kept filled by a motor-driven belt conveyor taking coal from a hopper beneath the railroad siding adjacent to the boiler room. Ashes are disposed of by a car (running beneath the boilers on a small track) into which the contents of the ash hoppers are discharged from time to time. Combination forced and natural draft is used, the blowers being directly connected to standard engines. Natural draught is supplied by a chimney 118 feet high and about 10 feet internal diameter.

A small stream, adjacent to the power house, with the city mains, furnishes the water necessary for condensing purposes, the intake well being located at the side of a reservoir formed from this stream. The main engines are disconnected from the condensing system by gate valves, when not in operation, these valves being controlled from the engine platforms.

The engines are of the Westinghouse-Corliss cross-compound vertical type, each of 2,000 indicated horse power, at 94 revolutions, with a capacity of 60 per cent. overload when run condensing and with a slightly increased initial pressure. The stroke is 48 inches, the high- and low-pressure cylinders being respectively 30 and 60 inches in diameter. Connected to the speed-regulating gear of each engine is a motor, operated from the switchboard, which changes the cut-off by adding weight to or taking it away from the governor spindle, this being effected through the interposition of suitable gears and levers. The purpose of this motor is to synchronize the engines when it is desired to run the units in parallel. The means for indicating the moment of synchronism are synchronizers on the switchboard, which, by the motion of a pointer over a dial, indicate which generator is running fast or slow. Since the generators are of the double-current type, this matter is very important.

The generators are of 1,250-kilowatt capacity each, the direct-current side discharging current at 650 volts into the Scranton end of the third rail, and the alternating-current side discharging current at 390 volts into the static converters, the secondaries of which are connected to the transmission line. The two exciter units, of 65 kilowatts each, are separately capable of furnishing the field current for both generators at full load, and are, consequently, operated intermittently.

Separate switchboards are provided for the direct- and alternating-current sides, the equipment of these boards being the usual standard apparatus for heavy work. The alternating current is handled at low voltage, before passing to the transmission line. Four 800-kilowatt transformers are used in translating the low-tension current into the high-tension current required for the line. These transformers are



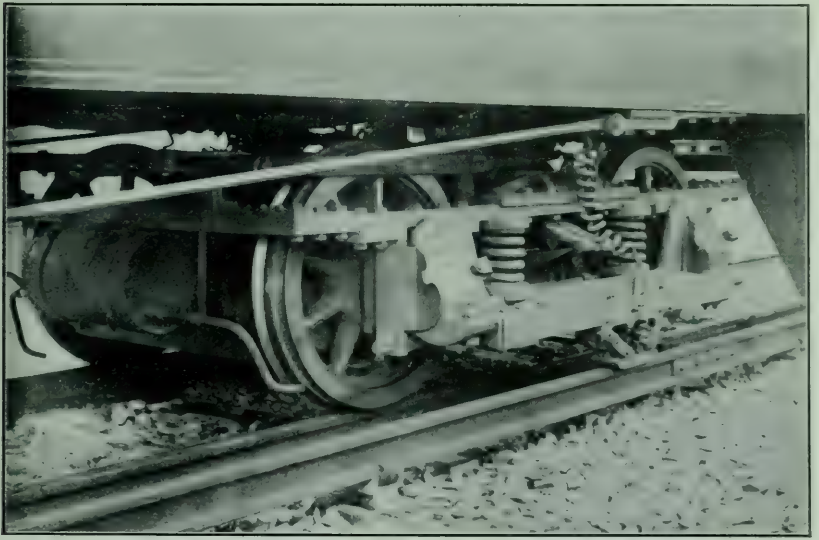
REAR OF DIRECT-CURRENT SWITCHBOARD, POWER STATION OF LACKAWANNA & WYOMING VALLEY RAILROAD.

The alternating-current switchboard is seen in the background.

placed beneath the engine-room floor at the opening shown in the latter, this opening being provided for the purpose of facilitating repairs, etc., by allowing the traveling crane to be used. Receiving three-phase (delta connection) current at 390 volts, they transform it into the 22,000-volt line current. Between the transformers and the line are the bayonet switches, by means of which any transformer may be disconnected. From here current passes through the static interrupters, to the line.

The static interrupters, which are illustrated, consist of a condenser connected between the lines and ground (this connection being on the side of the apparatus to be protected), and a choke coil connected in series with the line, the free end of the coil being connected to the condenser. The coil and condenser are placed in a self-cooling wrought-iron casing filled with insulating oil, the oil being necessary on account of the high voltage used, and also to radiate the heat generated. The coils are very heavily insulated, being intended to withstand static discharges. The condenser consists of a number of sheets of rounded rectangular copper, between which are interposed insulating sheets, the alternate copper sheets being connected to the line and ground respectively. One static interrupter is used for each line wire.

The line wires are of No. 4, B. & S., bare copper, suspended on umbrella-type glass insulators arranged in an equilateral triangle on poles 100 feet apart. This line passes to the sub-station at Plains, some 14 miles distant. The line enters the high-tension tower at this sub-station, which also serves as a passenger station, and connects with fuse switches, static interrupters, and low-equivalent lightning arresters. Connection is then made to two banks of static converters which reduce the tension to 390 volts, at which pressure it enters the two 400-kilowatt rotary converters and is converted into direct current at 650 volts for the third rail at this point.



MOTOR TRUCK, CARS OF THE LACKAWANNA & WYOMING VALLEY RAILROAD.

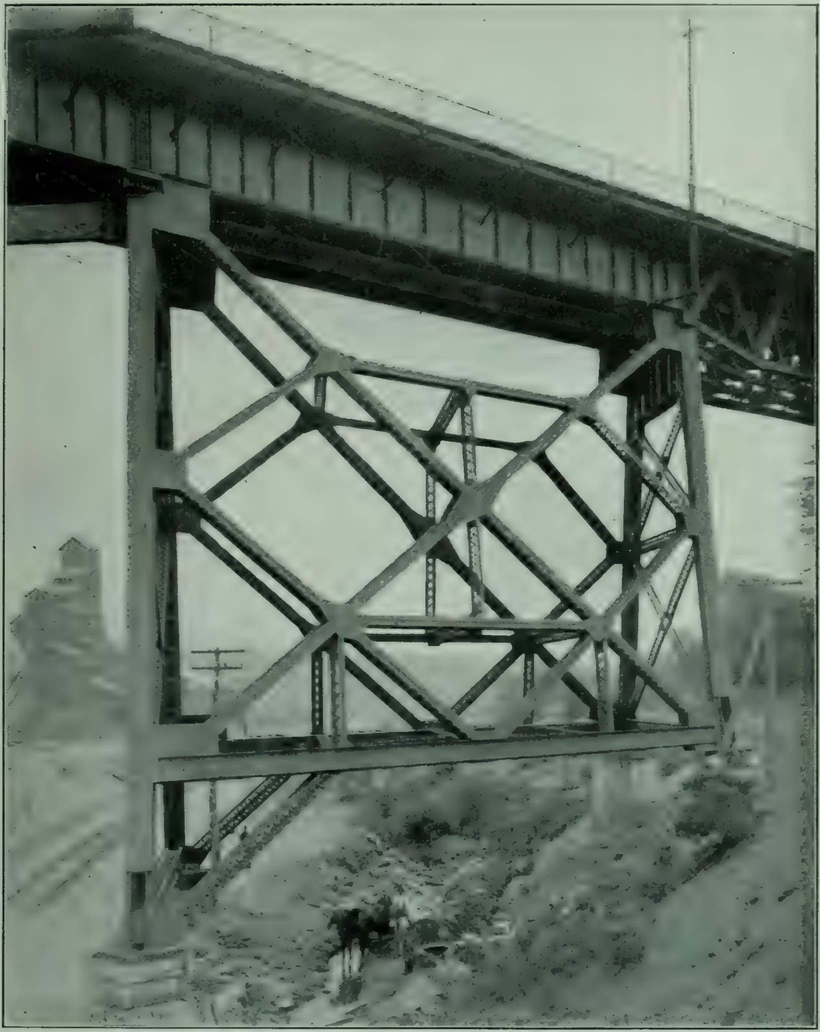
As stated before, the very highest standard of steam-railroad practice had to be followed, to fulfil the original design of the owners, which called for high-speed service and heavy freight traffic. Speeds of 50 miles an hour are of regular occurence, and the time-table schedule of all trains between Scranton and Wilkes-Barre is about 30 minutes, including many stops.

The main line between Scranton and Wilkes-Barre is of 90-pound A rail, and that between Scranton and Carbondale, 75-pound A rail. Guard rails and braces are provided at all curves, cross rail bonds being provided at frequent intervals. The ties are spread 2 feet apart, every fifth tie being longer, and carrying an insulator of artificial granite for the third rail. This latter is a 75-pound A rail, the separate rails being bonded with a heavy flexible bond placed beneath the web.

A PORTION OF THE ROAD BETWEEN SCRANTON AND MOOSIC, LACKAWANNA & WYOMING VALLEY RAILROAD.

The right of way is fenced off along the entire route by a galvanized-iron wire fence. All grade crossings are protected with cattle guards, the continuity of the third rail being broken.

Scarcely any of the grades are greater than 2 per cent. The almost entire absence of curves has called for a number of heavy engineering feats, such as but few steam roads of the same length have encountered. Another reason for this work is the great competition which exists, owing to the fact that a number of coincident and well-established steam roads are in the same territory. Securing a permanent way of such solidity in a region thus covered is of itself a triumph in engineer-



DETAIL OF THE AVOCA VIADUCT, LACKAWANNA & WYOMING VALLEY RAILROAD.

ing. It was of the opinion of many engineers that a location like that accomplished was an impossibility.

In many cases where the road crosses public highways, railroads, or streams, steel bridges are built, these being supported on concrete or stone abutments of massive character. The longest of these is the Avoca viaduct, which is 680 feet long and crosses the tracks of the Lehigh Valley R. R., Delaware and Hudson R. R., and the Scranton Traction Company's lines. This viaduct is composed of eight spans, seven of these being formed of plate girders. Roller bearings are provided at all points where expansion is expected. In approaching Wilkes-Barre, there is another viaduct 554 feet long which crosses the Wilkes-Barre Traction Company's lines and the Lehigh Valley R. R.; about 800 tons of steel were used in the construction of this viaduct. South of this viaduct is an embankment for about ¼ mile along the bank of the Susquehanna River.

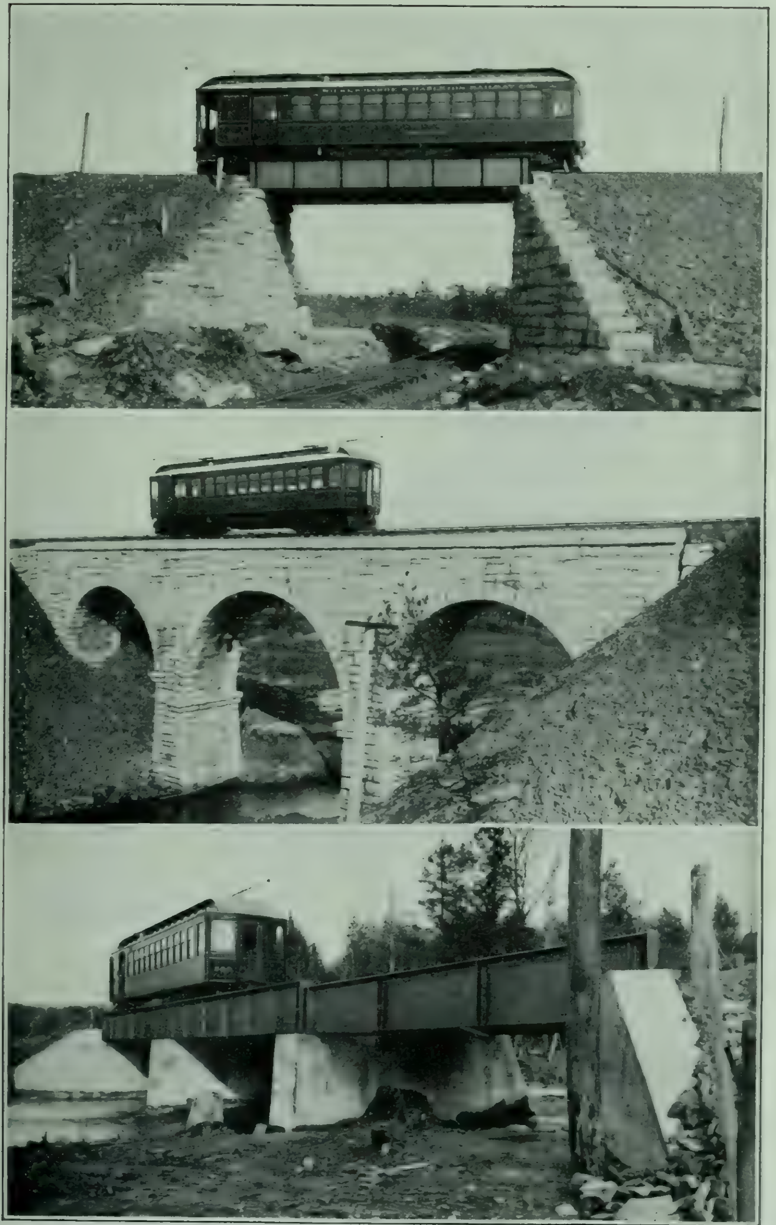
The rolling stock is designed for high-speed purposes, and is, consequently, of very heavy construction. M. C. B. equalized swing-motion bolster-type trucks are used, the rear truck carrying, on Gibbs suspension, two single-reduction motors, of 150 horse power each. Cast-steel wheels with steel wires are used. Each car is provided with motor-driven air compressors and automatic air brakes.

The equipment of the Wilkes-Barre and Hazleton Railway, although not as extensive as the one above described, is of the same high order of construction. The power house, which is located at St. Johns, about nineteen miles from Wilkes-Barre, is a rectangular structure of brick, and forms both engine and boiler house.

The generating equipment consists of three 400-kilowatt, 390-volt, 3,000-alternation, revolving-field, three-phase, Westinghouse alternating-current generators running at 115 R. P. M. The field current is furnished by two direct-connected 25-kilowatt, 125-volt, direct-current generators, driven by Harrisburg piston-valve engines at 300 revolutions. Each exciter is capable of supplying the field current for two of the alternators.

The alternators are driven by Fitchburg simple, horizontal, cross-connected 36 by 18 inch engines. Both cylinders are controlled by the same governor and valve gear, and either may be operated independently in case of light load. Each engine is fitted with an adjustable weight on the governor spindle, the leverage of this weight being changed through the medium of a threaded rod, which passes through the weight, by a small motor having suitable speed-reducing gearing. The engines are also fitted (both cylinders) with an automatic engine stop, which operates at ten revolutions above the normal speed. This stop consists of a centrifugal circuit closer, belted to the crank shaft and controlling the circuit of an electro-magnet. The armature of this electro-magnet, on being attracted, allows a weight to fall, thus releasing the valve trips and shutting steam from the engine.

The boiler room contains four 300-horse-power Heine safety tube boilers, operating at 135-pounds pressure, the feed water being supplied by two Deane double-acting pumps of the plunger type.



BRIDGES ON THE LINE OF THE WILKES-BARRE & HAZLETON RAILWAY.

At the top is a bridge over the Lehigh Valley tracks; in the middle, the stone arch bridge over Black Creek; at the bottom, the Wapwallopen bridge.

From the generators, current passes to six static transformers, arranged in two banks, two transformers being provided per phase (delta connection). The secondaries of these transformers are flexibly connected to bayonet switches, the fixed contacts of which are connected to the line on large triple-petticoat porcelain insulators. Interposed between the line and these switches are the reactance coils, condensers, low-equivalent lightning arresters, and fused switches.

The static transformers raise the pressure of the current to 15,000 volts. The line wire is No. 4 B. & S. bare wire, the conductors being arranged equilaterally on umbrella-type insulators. Arranged on the poles along the entire route is a telephone circut, to which, in cases of emergency, connection may be made with a portable set every 1/3 mile. A rotary transformer is provided at the generating plant to supply the third rail with direct current at this point.

From St. Johns the line passes to a sub-station at Nuangola, 13 miles distant. This sub-station contains a 400-kilowatt 500-revolution rotary converter and three static converters, the high-tension alternating current being translated into direct current at 625 volts for the third rail. On account of the increase in traffic, the transmission line is being extended from Nuangola to Ashley.

A portable sub-station, which may be used on any part of the road where the transmission line is at hand, is used when the traffic is very heavy. This sub-station consists of three static and rotary converters, with a switchboard, housed in a car of very heavy construction. Facilities for rapid connection to the third rail and line are provided, lightning arresters protecting against high-potential discharges.

The track is single, except where cars pass one another; the construction being similar to that of the system already described, the third rail being protected by a 2 by 5 inch timber placed 5 inches above the top surface of the rail, and supported by cylindrical porcelain insulators, placed on every fifth tie. Owing to the mountainous country traversed, the route is very circuitous and a number of heavy grades were encountered. Large cuts and fills were necessary along the entire route. About five miles from Wilkes-Barre a long tunnel was cut through Fairview Mountain, directly beneath the Lehigh Valley tracks.

The cars are of the same construction as those of the Lackawanna and Wyoming Valley, and are equipped with both hand and air brakes, the hand brake having a great leverage, and being used only in cases of emergency. The motorman's cab is placed at one side of the entrance cab, all working levers being arranged conveniently.

THE BIG STONE GAP COAL-FIELD OF VIRGINIA AND KENTUCKY.

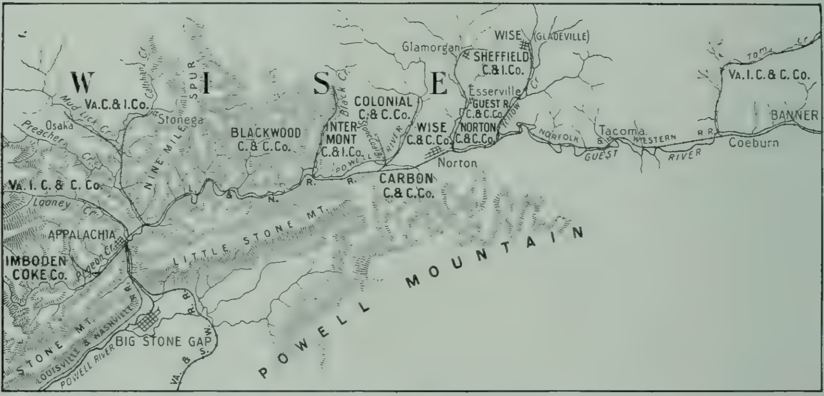
By John Leggett Pultz.

Mr. Fowler's account of the Pocahontas coal-field, which we published in May and June last, dealt with a region which is of importance because of its possible contribution to the steam fuels of the world. The coal measures described by Mr. Pultz in the following pages have a like interest, through the promise they give of rivalling the Connellsville seams in furnishing the great metallurgical fuel—coke.—THE EDITORS.

THE coal-field is located in the central portion of the Appalachian coal basin in southwestern Virginia and southeastern Kentucky. It is a long, narrow basin varying from 12 to 15 miles in width and extending in a northeast-and-southwest direction for a distance of about 36 miles. The field is approximately 540 square miles in area, and includes a deeply dissected region made up of ravines and steep ridges, which in the eastern portion of Wise County attain altitudes of over 4,000 feet above sea level.

The early settlers in this part of the country undoubtedly mined the coal on a small scale for domestic use, but the history of the field really began with the systematic extraction of the coal on a large and economic basis. In 1880, several wealthy mine owners in the anthracite field of Pennsylvania became interested in the Big Stone Gap Field. One of these gentlemen, a Mr. Leisenring, purchased a tract of land located in Wise County, Virginia, comprising 67,000 acres and afterwards held under the title of "The Virginia Coal and Iron Company." Strange to say, although Wise is today the largest coal-and coke-producing county in the State, still it was the last to be developed. Not until 1891 did railroads penetrate the field, and then the Clinch Valley Branch of the Norfolk & Western, and the Cumberland Valley Branch of the L. & N. Railway, were constructed with their terminals at Norton. The South Atlantic & Ohio, now the Virginia & Southwestern, has its terminal at Appalachia and gives this field an outlet to the southeastern markets. The completion of these roads gave the necessary outlet for the Wise County coal and coke, besides stimulating development work to such an extent that nine mines were soon in operation, and the total coal production for the ensuing year reached 124,088 short tons.

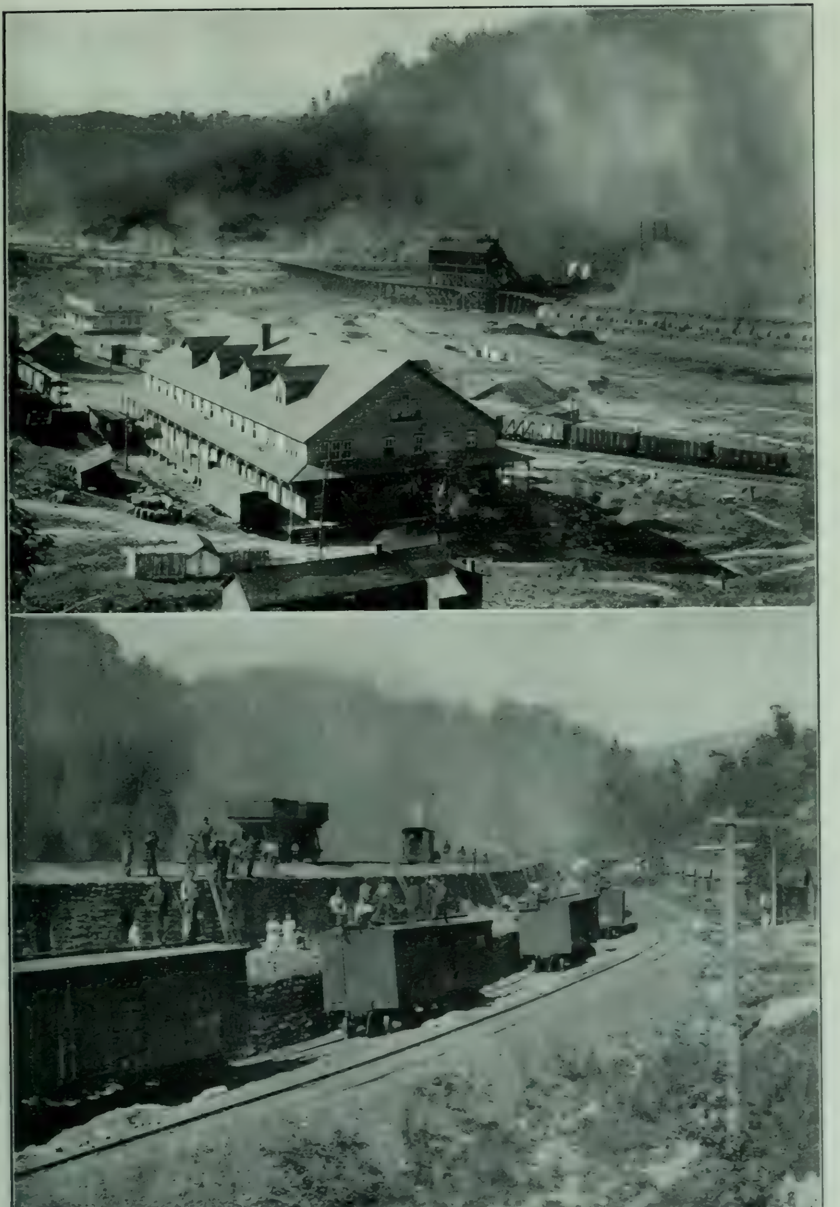
In 1895 the first coke was produced in the district by the Wise County Coal Company and the Big Stone Gap Colliery Company, while a third operation, known as the Virginia Coal & Iron Company, had a battery of ovens under construction. The Virginia Iron, Coal & Coke Company, one of the largest plants in the region, started on a small scale in 1896 under the name of the Tom's Creek Coal Company, which was later improved so extensively that the output of this mine alone was a strong factor in the increased annual coal and coke production of Wise County. At the close of 1896, there were 100 new ovens building at Stonega, which brought the number of ovens owned by the Virginia Coal & Iron Company up to 500 and made the total number in the district 834, all of which had been constructed within the short space of three years.



MAP SHOWING LOCATIONS OF THE COKE OPERATIONS IN THE BIG STONE GAP COAL-FIELD, WISE CO., VA.
Scale, 1 inch equals 6.5 miles, nearly.

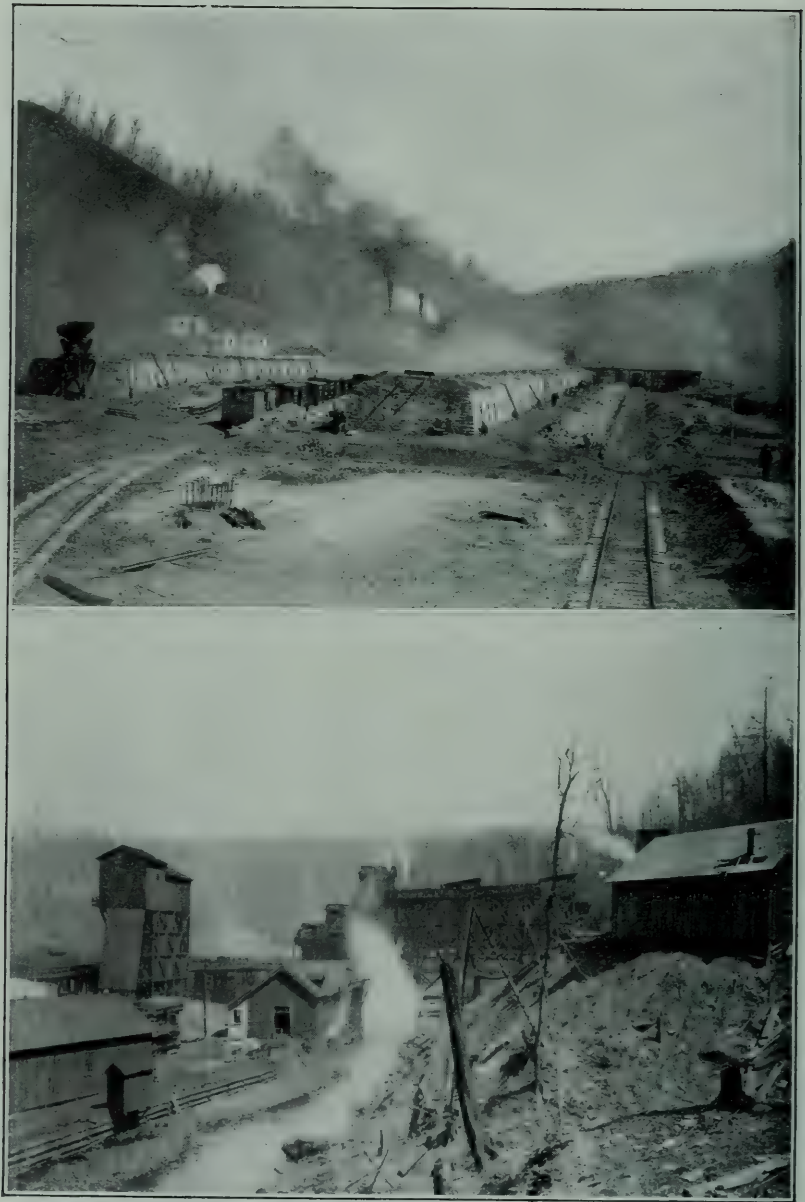
Development work, once started, progressed with great rapidity. Since 1893 the annual coal production of Wise County has doubled three times, passing 1,000,000 short tons in 1899, 2,000,000 short tons in 1902, and at the close of 1903 this last yearly output has been increased to 2,563,000 short tons. In brief, at the end of the first ten years of the life of the region the coal production of the field was more than twenty times the output of the first year.

Tazewell and Wise are the only two important coal and coke-producing counties in Virginia. The output of Montgomery, Pulaski, and Chesterfield Counties together was only 36,823 short tons in 1902. The coal production for Wise County this same year reached 2,422,417 short tons, against 723,753 short tons in Tazewell. The coke produced in Wise County is made from coal mined



TWO OF THE OPERATIONS OF THE VIRGINIA IRON, COAL & COKE COMPANY.

The upper view is the Tom's Creek plant; the lower, the coke ovens at Inman, Va.



TWO VIEWS OF THE MINES, TIPPLES, AND OVENS OF THE VIRGINIA COAL & IRON CO., AT STONEGA, VA.

within the boundaries of the State, a fact that applies to no other county. At the present time, there are 3,414 ovens in the district, which produced 80 per cent. of the Virginia coke output.

Having roughly followed the growth of this field from its early history up to the close of 1903, it remains for me to describe briefly the geologic conditions existing in the basin and to discuss in some detail the occurrence of the workable seams.

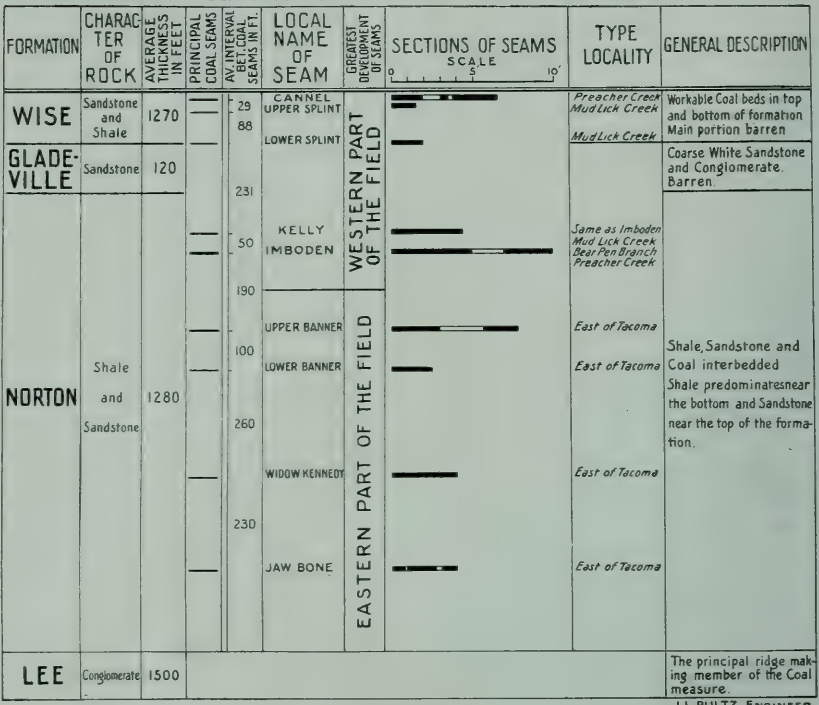
THE COLONIAL COAL & COKE CO., DORCHESTER, VA.

The small cross mark on the ridge indicates the position of the 8 to 10 foot seam shown in Mr. Esser's section, measured at Dorchester, referred to on page 79.

Big Stone Gap is a deep gorge cut by Powell River through the sharply folded formations of the Carboniferous, comprising the bulk of Stone Mountain, a northeast-and-southwest ridge, the southeastern portion of which carries Devonian beds rising abruptly from the wide valley in the Silurian measures to the south. This gap has been of great economic value in the development of the field, for it has enabled the Virginia & Southwestern and the Louisville & Nashville Railroads to construct their lines along Powell River, and to send short spurs northward up the many tributaries into the heart of the coal measures.

Seven distinct formations have been recognized in the Carboni-

GENERALIZED SECTION OF THE BIG STONE GAP COAL FIELD VA.



FORMATION	CHARACTER OF ROCK	AVERAGE THICKNESS IN FEET	PRINCIPAL COAL SEAMS	AV. INTERVAL BET. COAL SEAMS IN FT.	LOCAL NAME OF SEAM	GREATEST DEVELOPMENT OF SEAMS	SECTIONS OF SEAMS SCALE 0 5 10′	TYPE LOCALITY	GENERAL DESCRIPTION
WISE	Sandstone and Shale	1270	—		CANNEL	WESTERN PART OF THE FIELD		Preacher Creek	Workable Coal beds in top and bottom of formation Main portion barren
			—	29	UPPER SPLINT			Mud Lick Creek	
			—	88	LOWER SPLINT			Mud Lick Creek	
GLADE-VILLE	Sandstone	120							Coarse White Sandstone and Conglomerate. Barren.
NORTON	Shale and Sandstone	1280	—	231	KELLY			Same as Imboden	Shale, Sandstone and Coal interbedded Shale predominates near the bottom and Sandstone near the top of the formation.
			—	50	IMBODEN			Mud Lick Creek Bear Pen Branch Preacher Creek	
			—	190	UPPER BANNER	EASTERN PART OF THE FIELD		East of Tacoma	
			—	100	LOWER BANNER			East of Tacoma	
			—	260	WIDOW KENNEDY			East of Tacoma	
			—	230	JAW BONE			East of Tacoma	
LEE	Conglomerate	1500							The principal ridge making member of the Coal measure.

J.L. PULTZ ENGINEER.

ferous of this field. The mean thickness of each formation is given in the following section:[1]

Name of Formation.		Mean Thickness in Ft.
Harlan	Sandstone	880
Wise	Formation	1,270
Gladeville	Sandstone	100
Norton	Formation	1,280
Lee	Conglomerate	1,500
Pennington	Shales	1,100
Newman	Limestone	930
Total thickness		7,060 feet.

The Norton is the most important formation of the series, for it carries the greatest number of workable seams. It is exposed continuously in the valley extending along the northern escarpment of Stone and Powell Mountains, and to the north in ravines cut by the tributaries of Powell River. The Gladeville sandstone is shown on the geologic map by a thin irregular band separating the Norton from the Wise formation which forms the highlands to the north. The Harlan sandstone is exposed in the high ridges in the western part of the field, while the two lowest formations outcrop over the greater portion of the territory lying to the south.

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[1] Bulletin III., U. S. Geol. Surv.

As a method of expressing concisely the relative positions of the principal coal seams occurring in the field, I have made a generalized geological section. See the opposite page.

Much confusion has arisen in correlating the seams outcropping in the ravines of the numerous local and somewhat disconnected basins. The prospector in most cases identifies a seam principally by its height above water, and ignores minor structural features, such as the numerous gentle folds, a detailed study of which only can definitely determine the positions of the different seams.

The coal beds of economic value range from 3½ to 12 feet or more in thickness, but a parting of several feet usually occurs in the thicker beds, such as the Imboden, making the total of the two benches at least 6 to 7 feet of clean coal. The generalized section shows eight workable coal horizons lying between the base of the Wise formation and a point 200 feet above the Lee Conglomerate, a distance of about 1,200 feet. The four highest seams, of which the Imboden and Kelly

LOONEY CREEK PLANT, VIRGINIA IRON, COAL & COKE CO.

PLANTS OF THE INTERMONT COAL & IRON CO.

The upper one is at Dooly, Va.; the lower is the Kelly & Irvin plant.

are the most important, reach their greatest development in the western portion of the field, while the lower four occur above water in the region to the east. The intervals between the seams vary greatly in the different parts of the field; I regret that this cannot be shown more clearly in the generalized section. Mr. John Esser gives the following section measured on the Colonial Coal & Coke Company's property at Dorchester. The section will illustrate the positions of the various seams in the central part of the field. The top seam lies in the ridge on the western side of Powell River about a mile north of the plant. It has only lately been opened up and shows a fine exposure of 7½ feet of coal, but owing to the extremely high position of this seam in the hills it appears to have a limited acreage.

Coal.....	6—7 feet.		Occurs in the ridge at the head of Bear Branch, about one mile north of Dorchester.
30 feet Interval.			
Coal.....	2—2 feet 6 inches.		
65 feet Interval.			
Coal...	4 feet. 3 " 4 "	Top bench. Sandstone. Bottom bench.	This is known locally as the "Double Vein."
80 feet Interval.			
Coal.....	8—10 feet.		This seam has lately been opened at Dorchester.
15 feet Interval.			
Coal.....	3 feet 8 inches.		
45 feet Interval.			
Coal.....	2 feet 6 inches.		
300 feet Interval.			
Coal.....	2 feet.		
40 feet Interval.			
Coal.....	8 feet.		Big Dorchester seam worked by the Colonial Coal and Coke Co.
36 feet Interval.			
Coal.....	1 foot 6 inches.		In some places this seam is only 4 to 6 feet above the Gordon.
15 feet Interval.			
Coal.....	4 feet 10 inches.		Known locally as the Gordon seam. It is being worked at Norton, Wise, and Dorchester.
40 feet Interval.			
Coal.....	5 feet. 4 inches of		parting. Worked at Norton, Wise, and Dorchester.

The Imboden is the most important seam in the district. It is continuous over a large area, but unfortunately its horizon in the eastern part of the field has not been determined with any great degree of accuracy. M. R. Campbell speaks of its possible correlation with a seam known locally as the Edwards, which occurs in the vicinity of Tacoma. The Imboden varies considerably in thickness, and shows

AN ELECTRIC LOCOMOTIVE HAULING MINE CARS IN THE BIG STONE GAP FIELD.

excellent exposures on Bear Pen Branch and numerous other ravines in the western part of the field, where it is extensively worked by some of the largest plants in the region. The following section measured on Preacher Creek shows about the maximum thickness attained by this seam.

PIGEON CREEK PLANT, IMBODEN COKE COMPANY.

Sandstone Roof.	Feet.	Inches.
Coal	11	..
Bony Coal	..	3
Coal	1	8
Clay	..	2
	—	—
Total	13 feet	1 inch.

There is but slight variation in the character of the more important coals in the district. The seams worked are bituminous and are classed among the high-grade coking coals. The physical properties of the Imboden seam are excellent, and it has a cubical structure formed by two well developed cleavage planes. The following comparative table gives the analyses of coal and coke in the Big Stone Gap and Connellsville Districts. The analyses of the Connellsville Coal and coke, taken from the XXII. Annual Report of the United States Geological Survey, are the averages of a considerable number of tests. The analysis of the Big Stone Gap coal is a fair representative of the Imboden seam, sampled on Looney Creek by McCreath, while the one of the coke is an average of a series of tests made over an extended period by the South Chicago Furnace Company on Imboden coke consigned to their plant in Chicago.

Big Stone Gap Field.			Connellsville Field.		
	Coal.	Coke.		Coal.	Coke.
Moisture	1.154	....	Moisture	....	0.184
Volatile Matter	35.346	1.48	Volatile Matter	31.04	.552
Fixed Carbon	60.107	87.91	Fixed Carbon	61.97	88.726
Ash	2.750	9.86	Ash	5.77	9.993
Sulphur	0.643	.74	Sulphur	1.22	.533
Phosphorus	.....	.01	Phosphorus	....	.010
Totals	100.000	100.00	Totals	100.00	99.998

Comparing the coals of the two districts, it will be seen the coal from the Virginia region is higher in volatile matter, somewhat lower in fixed carbon, and very much lower in ash than the Pennsylvania coal.

The analyses of the cokes show that there is a marked similarity between the corresponding constituents. As to physical properties, the coke made in the Big Stone Gap Field has an excellent cell structure, and the prevailing opinion among both furnace and foundry men is that it equals the Connellsville product.

As already stated, the ash content in the Imboden coal often runs very low, and in order to obtain a structurally strong coke, it is often found necessary to add a quantity of rash, occurring in the middle of the seam, sufficient to bring the content in the coke up to 10 per cent. The coal is subjected to a preliminary crushing which reduces it to a size varying from 1 to 2 inches. This treatment serves to mix the coal and rash thoroughly and greatly facilitates the coking.

The mining operations in the regions are confined to the area lying north of Powell and Guest Rivers. No workable seams occur in Stone Mountain to the south. Table III gives the principal coke operations in Wise County, besides the location, number of ovens, and estimated coke output of each plant. Many of these operations, as the Virginia Coal & Coke Co., the Virginia Coal & Iron Co., and the Colonial Coal & Coke Co., also ship a large quantity of coal.

TABLE III

COKE OPERATIONS IN WISE COUNTY, VA.

Name.	Location of Operation.	Number of Ovens.	Coal: Estimated Daily Requirements for Ovens in Tons.	Coke: Estimated Daily Output in Tons.
Imboden Coke Co	Pigeon Creek, Bear Pen Branch	289	875	578
Virginia Iron C. & Coke Co	Looney Creek	168	500	336
Virginia Coal & Iron Co	Osaka	350	1,000	700
“ “ “	Stonega	666	2,000	1,332
Blackwood C. & C. Co	Blackwood	200	600	400
Intermont C. & I. Co	Josephine	60	180	120
Carbon C. & C. Co	Middle Norton	20	60	40
Colonial C. & C. Co	Dorchester	450	1,350	900
Wise C. & C. Co. (Auxiliary plant of Colonial C. & C. Co.)	“	50	150	100
Norton C. & C. Co	East Norton	110	330	220
Guest River C. & C. Co	Esserville	51	150	102
Sheffield C. & I. Co	Glamorgan	200	300	400
Virginia Iron C. & C. Co	Toms Creek	800	2,500	1,600
		3,414	9,995	6,828

Although the structure of the region is somewhat complicated, the gentle character of the broad folding has only slightly tilted the coal seams and it is therefore possible to conduct mining operations under extremely favorable conditions.

The method of mining employed is the room-and-pillar system. The coal is generally attacked by parallel-face headings 8 and 9 feet wide, with a 50-foot pillar between them. These dimensions apply to 600 feet of covering. At intervals of 400 feet, cross headings are driven right and left and rooms 20 feet wide and 300 feet long are turned off in both directions, leaving 30-foot pillars. It is doubtful if more than 75 per cent. of the coal was formerly recovered. Recently, however, there has been much improvement in the methods of mining, and under favorable conditions this figure should be raised largely.

Ventilating furnaces are in use at the majority of the mines, but when the workings begin to assume large proportions the necessary ventilation is produced by means of exhaust fans.

Underground haulage is accomplished by mules and electric locomotives of the Baldwin, General Electric, and Jeffrey types, ranging in weight from 10 to 17 tons. When the workings are in a narrow spur, there is often a considerable outside haul between a series of drifts. In several localities, where the seams occur exceptionally high in the ridges, short inclines equipped with barneys are in use.

Tipples are erected at the terminal of the trolley roads connecting the different openings, and they are usually at a considerable elevation above the valley floor. Long chutes of 45-degrees gradient connect the tipples and bins, which have a capacity of at least one-day's output in order to insure against any delay in charging the coke ovens. In the most recent type of bins, the crusher is located directly beneath the screens in the chute and the fine coal is placed in the pockets by means of conveyors.

There is considerable difference in the power plants of the numerous operations; at a few of the older workings, electricity is not used at all. Up to the present time electricity has in most cases been applied only to haulage. The Norton Coal & Coke Co., however, is electrically equipped throughout, and is one of the few operations in the district mining coal with machines. A type of plant applying electricity to both the underground and surface haulage systems is shown in the view (page 80) of the Imboden Coal & Coke Co.'s mine on Pigeon Creek. This mine has been in successful operation since its completion a year ago and has a coal and coke output of about 900 and 600 tons respectively. The power-house equipment consists of two Atlas boilers of 150 horse-power each, and one McEwen engine rated at 275 horse power which is belted to a Jeffrey 150-kilowatt generator supplying a current of 250 volts.

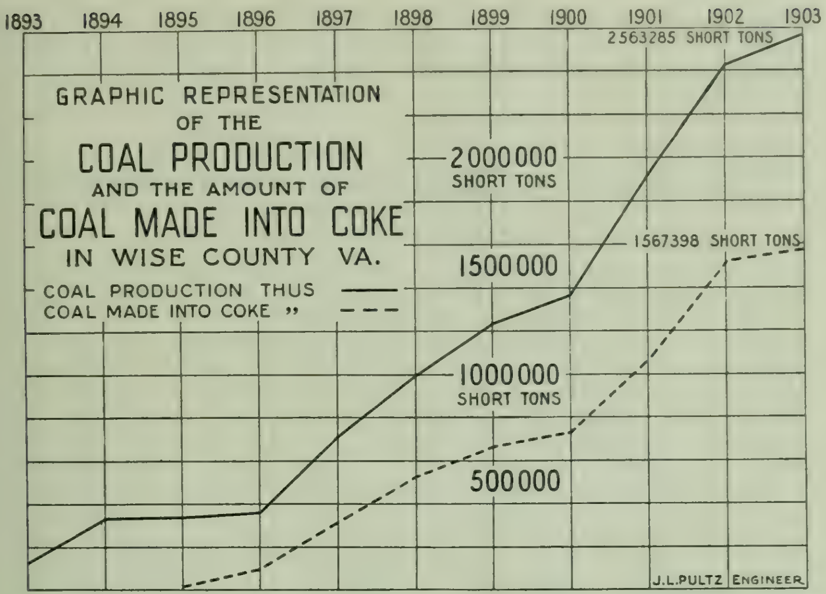
The Stedman type of crusher is in use at the greater number of operations. It is the general practice to run the crushers by steam. At the Norton Coal & Coke Co., electricity is employed for this purpose and has rendered efficient service without serious mishap for a considerable period. The opinion seems to be that the fine coal dust will cause trouble, but at Norton this is avoided by a dust-proof casing.

The coke ovens are of the standard bee-hive type and are built mostly in double batteries, but several plants have single batteries of bank ovens. The latter style of oven has many disadvantages, foremost of which is an extremely poor draft which necessitates a longer coking period. The Minor brothers have built the greater number of ovens in the district. These ovens are of excellent construction and have a 12- or 12.5-foot floor and a 6-foot-6-inch crown. The doors are high and of sufficient size to allow exceptionally large charges, a fact that greatly influences the cost of coke when drawing is by contract. It is the custom to make 48-hour coke four days in the week, and to begin charging 72-hour coke on Saturday in order to avoid Sunday work. The quantity of coal charged to the ovens varies with the coking period. The first 48-hour charge is from 5.5 to 6.6 tons, and the second ranges between 6.6 and 7.5 tons, while the 72-hour coke requires 8 to 9 tons of coal.

The coke larries are of 7- and 8-ton capacity and have double discharge. In the smaller plants mule haulage is used, but in the larger operations steam and electricity are more efficient. Both the third-rail and trolley systems are in operation. The trolley applied to coke ovens has proven satisfactory, and the motor larries are of sufficient power to haul several trailers.

The market for the Big Stone Gap coke embraces a considerable area. The greater part of the product goes north, and the trade with points northeast of Cincinnati is growing rapidly. Several iron companies, such as the Virginia Iron, Coal & Coke Co., and the Sheffield Coal and Iron Co., owning plants at Inman and Glamorgan respectively, consume their own coke when their furnaces are in blast. The coke of this region can be made at a cost permitting it to enter into active competition with the high-grade products of other fields. The furnace and foundry coke can reach all the territory northwest of Columbus and Cleveland. There is a demand for coke for smelting and foundry purposes in Mexico and the southwest, and the Big Stone Gap Field seems capable of supplying this market. In ordinary times shipments are made to Gadsden and Sheffield, and under the most favorable market conditions as far south as Birmingham. At the present time about 1,000 tons per day of coke is being shipped to the T. C. I. & R. R. Co., Alabama Consolidated Iron Co., and other furnaces in the Alabama district.

The coal output of this region will increase greatly, but the excellent coking qualities of the coal will always make the field essentially a coke producer. Virginia and North Carolina are accessible, and



the seaboard can be reached at Norfolk where there are prospects for a large export trade. The Western coal market has not been exploited to any great extent, owing partly to the absorption of the coal output in the manufacture of coke. A large trade is being opened up in South Carolina, North Carolina, and Georgia, owing to favorable freight rates. It is said that the coals of this region can be marketed in any territory where the freight rate is not more than 30 cents higher than from the Tennessee mines. Where it comes in competition with the Pocahontas, Kanawha, New River, and Connellsville districts, the rates must be in favor of the Big Stone Gap field. The market for the coal of this region is much more limited than that for coke, but the territory to the south and east is capable of greatly increasing the present comparatively small output.

Admirable work has been done in the development of this region. Many of the operators are Pennsylvania men, and to their excellent training in the northern field is due the high economic efficiency of their operations, a fact that has given the Big Stone Gap Field the title of the "Southern Connellsville." This title is certainly earned, as this region yields a coke which is the most serious competitor, both as to physical and chemical qualities, which the Connellsville operators have to meet outside of their local market.

STEAM COSTS IN INDUSTRIAL COMBINATIONS.

By William D. Ennis.

While Mr. Ennis discusses his subject primarily from the standpoint of the manager of a number of associated plants, almost all his practical suggestions for determining steam costs apply well also to the individual factory.—THE EDITORS.

THE fallacy has long been exploded that the combination of two or more kindred industries posseses in itself any economic virtues from a manufacturing standpoint. The condition of industrial consolidation, like any other industrial condition, naturally presents lines of least resistance along which profitable policies evolve. Combinations offer characteristic opportunities, just as an independent and strictly competitive business naturally develops certain tendencies under competent management. Measuring value of opportunity by facility and completeness of achievement, it cannot be said that chances for economies under a system of industrial combination are of necessity any better than under independent organization.

This is especially true in connection with steam costs. A pound of coal is a pound of coal, and a British Thermal Unit has an invariable value, to the Steel Corporation or to the smallest tank shop. In one respect, however, a combined industry has a decided advantage—namely, in the possession of comparative data regarding the performance of similar plants. But such data can frequently be obtained by the independent, also; and even the possession of such data is of potential value only, the discrepancies between costs which are shown to exist depending rather upon the character of plant respectively possessed than upon radical difference in competency of management.

It is not the province of this article to discuss late developments in steam-generating and utilizing machinery. The assumed condition is that of a plant already equipped with boilers and engines of average grade, in which, without contemplating large expenditures for radical and thorough revision, the engineer is expected to reduce the cost of steam. Arguments for and against the use of superheat, turbines, electric driving, economizers, etc., are obviously out of place. The subject is rather those methods of organization and operation of existing equipment in an integrated industry which have been found to reduce costs.

The head of the department should be a technically trained engineer—one having had previous experience in the industry which he is to serve, and thoroughly familiar with its power requirements and conditions. He should have advisory, though not absolute, jurisdiction of the plant superintendents, and should correspond with them and not with the plant engineers on matters pertaining to the steam departments of the various mills. Otherwise there is a division of responsibility for the economical conduct of mill operation. Reports covering the performance of the steam department at each mill should be made by the superintendent from information received from the mill engineer. The engineer in charge of the steam department should spend a large portion of his time at the mills, and when thus locally visiting should be expected to confer informally with the mill engineers, making suggestions and giving directions that could be thus better carried out than by filtration through the non-mechanical mill superintendent. He must consequently be a man of considerable tact and force of character; and, as much of the control of the cost of operation of his department is in the hands of an official who is not wholly and directly responsible to him, he should have the faculty of getting along with men pleasantly and profitably, and of accomplishing much by that form of suggestion which is the equivalent of a command, and by a memory which never blots out the record of things undone which should be done.

In computing the cost of steam, the following expenditures should be included:—

Coal or other fuels
Engineers
Firemen
Laborers
Mechanics
Lubricating oils, used on engine-room machinery
Waste
Water
Supplies, subdivided if necessary
Engine and boiler repairs

Should any of the above be applied to other purposes than the production of steam, a proper credit should be made to the steam account. For instance, if the chief mill engineer is also the head mechanic, the general repair account of the plant should be charged with its proportion of his time. If water is used for other than boiler-room purposes, as for various manufacturing operations, the steam department should not stand the entire water bill.

In an industry composed of large plants (say 3,000 horse power and over) it would probably be advisable to separate the disbursements completely into the ten classifications above given, with additional subdivision of expenditures for supplies, if necessary. In small plants (1,000 horse power), the four steam accounts—fuel, labor, repairs, and supplies may be sufficient.

The chief mill engineer should have general jurisdiction over all repairs to the mechanical plant—shafting, belting, electrical equipment, lighting, wiring, pumps, etc., for upon the good condition of these the consumption and consequently the cost of steam to a considerable degree depends. In order that he may have time and opportunity to leave the engine-room so as to be free to supervise or personally conduct various repair jobs, he should be given an oiler, competent to have charge of the engine-room in operation with his chief within call. At other times this helper can be used in the fire-room and on repairs. The machine shop should be close to the engine room and separated from it by glass partitions, so that a man in either room is to all intents and purposes in both. The night engineer should be considerably lower paid, the day job to be always in his view a highly desirable promotion. In small plants he should do his own oiling and should have no engine-room assistant. Where an eight-hour or three-tour system is practised, for either engineers or firemen, it is frequently possible to work the fire-room and engine-room helpers on a ten or twelve-hour trick. In this, as in all other industrial organization, it is unquestionable that for good results there ought to exist the widest possible distinction between the commonplace and the capable employee. The reward for efficiency should be made sufficiently great to stimulate every man to do his best, and each man should be given to understand that promotion is as readily possible for him as for anyone, upon demonstration of superior capacity. Small rewards, parsimonious recognition of merit, make employees inert and indifferent. The rank and file should have the private's pay and privileges; but the man of genuine worth should be invited to demonstrate his value in unquestionable ways, and should understand that for high-grade service there is a reward correspondingly high within his reach. There should be no levelling tendency in business.

The mill engineer, for the wages usually paid in such positions, will not be a technically trained man He should be a thorough economical mechanic, experienced in the machine shop and fire-room, with good horse sense about questions of safety and strength, and sane notions on matters of combustion and engine economy. He should have absolute control of the personnel of his department, and must therefore be a man of executive ability within his field. He must be broad-minded enough to accept suggestions on modes of operation the philosophy of which he may not comprehend, and honest enough to execute intelligently what others may plan.

The selection of supplies for the use of the steam department should be based upon recommendations by the chief engineer of the company, who will derive his information partially, of course, from reports by the mill engineers. The actual purchasing should be left wholly under the care of the general purchasing department.

Various elaborate reports are used to enable the chief of the department to keep posted on the operation of each mill. But if the cost of coal per unit of product is as low as it has ever been, and as low as it is in any other plant, conditions considered, then the engineer had better devote his first attention to some other economy more immediately opportune than those which might be suggested by a closer analysis of the returns.

In nearly all cases, the cost of fuel constitutes more than half the cost of steam—sometimes, in very large plants, fuel amounts to nine-tenths of the total; and, if he fails everywhere else, the steam man who can reduce the cost of fuel will probably show an economical result in the operation of his department. This cost depends upon the following factors: the price of fuel per ton; the evaporation of water per pound of fuel; the consumption of steam per horse power of the engine units; and the amount of horse power used by the plant. With the first of these the mill engineer usually has little to do, his work being limited to the accurate comparison of the evaporative values of such coals as may be chosen for trial. The second and third factors are wholly under his control. The fourth is also, to a degree depending upon the man himself and the co-operation he may receive from other departments.

In order to have a complete general knowledge of the performance of the plant with respect to the three factors last named, the following data must be obtained:—

Fuel consumed
Water evaporated
Horse power developed
Product of the plant.

These can all be obtained, and should be obtained, with very little expense, for each day's operation. It is best, of course, to actually weigh the coal burned. This is less difficult than would appear at first sight. A barrow or car can be filled to the limit, the weight determined, and a record then kept of the number of times the barrow or car is emptied during the day. This plan usually results in a gradual gain in inventory of coal on hand, but the results are not perceptibly inaccurate. A rough check on the consumption as thus determined, and a good check on the economy of combustion, may be obtained by daily weighing the ashes produced. In small plants, or those where, for other reasons, actual weighing of the fuel is impossible, a little practice enables very close results to be obtained by measurement. Separation of the body of fuel in storage into compartments makes the estimation easier. Even split wood, unpiled, can be closely approximated after a few trials.

It is well understood that water meters are not sufficiently accurate for test purposes, and the mechanical difficulties in construction appear to be especially troublesome in the case of hot-water meters. For approximate indications of the daily evaporation of a plant, however, the meter is satisfactory, being in fact the only method practicable of obtaining any statement of the amount evaporated. In all cases where possible, the water should be measured cold. Frequently, where city water is used, the consumer's meter on the suction side of the feed pump may be employed, the suction in such cases being always under pressure. It does not matter if a small amount of this water is used for other purposes than boiler feed, so long as this amount is limited, known, and controlled; the object is to obtain comparative rather than exact figures. The approximate nature of such returns makes periodical readings of the feed temperature and steam pressure, and corrections of evaporation based thereon, unnecessary.

Some curious results are obtained by a careful study of even these rough water-meter readings. In one case, when the plant was partially shut down, the quantity of water consumed appeared to be too large, and it was found upon investigation that the turbine wheel used for removing scale from the tubes of a water-tube boiler, attached to the city water supply, was using $10 worth per day of this commodity at 10 cents per 100 cubic feet. Connection of the water-motor pipe to the condenser pump disposed of this extravagance.

The horse power developed by the engine equipment may be, and in some cases should be, determined by taking indicator cards at frequent intervals. For this purpose, the steam indicator and reducing motion should at all times be attached to the engine. In an electrically driven mill, the power developed can be, of course, computed without the aid of the indicator. In such a case, it may be desirable, however, to use the indicator as a closer check on engine economy than measurements of electrical power alone would give. Indicator readings of the steam engine in a manufacturing plant do not, however, wholly represent the amount of power developed. Steam is invariably used for other motors than the main engines; sometimes, also, for other than power purposes. It is necessary, therefore, to have some means of arriving at the steam consumption for these various purposes. In order to do this, the engineer must occasionally make economy and duty tests of all engines and pumps, and must devise methods of approximating the quantity of steam used in various processes. Where the steam, after use, can be condensed, it is easy to determine the amount consumed under different conditions. If the steam cannot be separately condensed, the determinations of the amount of flow through a given orifice at various differences of pressure can be made by an independent calibration, in which the steam is condensed, and the figures thus obtained used in computing the consumption in process. This is the method used to regulate and calculate the amount of steam used in fuel-oil burners. The orifice best consists of a small hole drilled through a diaphragm bolted between faced flanges. A set of diaphragms should be provided. By ingenious testing, the engineer may develop rough and ready rules, which are nevertheless surprisingly accurate, for estimating the quantity of steam that is being used by the various pieces of equipment supplied.

This general information is used as follows:—from economy tests of his engines, the steam man will have determined the steam used per horse power between certain limits of load. Multiplying this by the horse power developed, as determined at intervals, he can compute the steam used by the engines. From duty tests of pumps, and observation of the amount and head of liquid pumped (even when approximating these last from the number of strokes), he can estimate the consumption by the various pumps. By weighing the condensation of steam employed to heat a certain weight of liquid through a certain range of temperature, he can ascertain how much steam is condensed per degree of heat for one pound of liquid, and thereafter may calculate the steam used by knowing the quantity and temperatures of liquid. From the calibration test for quantity of steam through an orifice, and by periodical gauge readings, he can obtain an estimate of the steam used or blown into any process from which it is not subsequently removed. For purposes where a large and fairly constant amount of steam is required, an estimate of the quantity is sometimes made by supplying this steam from a separate boiler or boilers, and weighing the feed water.

The engineer is then in possession of a statement showing where all the steam generated has been used. This should be balanced against the recorded consumption of feed water. With such data, an increase in cost of fuel can be analyzed with some degree of certainty. It should at least be possible to know whether the increase has been due to improper methods of firing in the boiler-room, or to extravagance in the use of steam. It is also possible to ascertain the cost of steam for improvements and special processes adopted.

This estimation of steam consumption, in addition to being approximate, is also temporary. The steam consumption of engines rapidly increases during a long and steady run. Other factors make the data obtained by tests less reliable as time goes on. It is assumed, however, that without regard to these variations, the engineer will have occasion to make economy trials of most parts of the plant several times in the course of a year; and such economy trials furnish just the data needed for his calculations. These calculations may be made either at the plant, or at the general office, from data furnished by the plant. The former is preferable, but there are few mill engineers who would have time or be ready enough at figures to make the computations. In any case, the final returns, showing proportionate amounts of steam used at various parts of the plant, should be accessible to the engineer.

The fourth item in the general *résumé,* namely, the product of the plant, is of course recorded by the superintendent. It may not in all cases be practicable to place these figures before the plant engineer, but the steam specialist must have them, for the full appreciation of his plant performance. When there are variations in the quality of product, which, like variations in its quantity, affect the consumption of steam, this fact will be indicated from inspection of the details of our third item, "horse power developed," and due regard should be paid such variations in making comparisons.

From the four items listed, the engineer may compute,

Evaporation of water per pound of coal
Power developed per pound of steam
Amount of product per unit of power,

and, by comparison of these figures along horizontal and vertical lines, may determine whether there is a lessened efficiency and a need of adjustment in boilers, engines, or process.

STORES ARRANGEMENT AS A FACTOR IN SHOP MANAGEMENT.

By John Ashford.

A recent request for data as to stores-room practice, sent to a large number of the foremost shops, brought in nearly 75 per cent. of the cases the general reply: "We are not at all satisfied with our methods. Our stores room is in the poorest condition of all the departments of our works. We are thinking of reorganizing it completely." No further suggestion is needed to emphasize the importance of Mr. Ashford's exposition of the stores room as the central department of provision, inspection, control, distribution, and protection of the whole works.

The first section, now presented, lays the general groundwork of the subject. A following article goes into specific detail, and will give the definite, practical instructions, forms, cards, etc., of a simple, non-cumbersome, and inexpensive system which will accomplish all the results suggested above, and many others of almost equal importance. It will also illustrate the practice of many of the newest establishments of the United States and Great Britain.—The Editors.

IT IS of but little use to put modern rapid-production machines and tools into a works unless the general scheme of works management and procedure is based upon equally modern lines. It would be about as wise to put modern rapid-fire artillery in wooden ships and expect them to win battles against modern ironclads, as to put high-class machine tools into a works without tool room, stores, and the corresponding methods of management, expecting them to make profits in competition with thoroughly up-to-date establishments. Yet this is actually done—only, however, in those factories where there is a pathetic clinging to the methods and doings of the past—where the way things were done twenty years ago is held up by way of example for the guidance of the rising generation.

The mere saying that there must be modern methods of management is not very helpful and naturally draws the query:—"What *are* the modern methods referred to?" Putting the matter in the most contrasting way we could say that modern methods to old-fashioned ways are as brains to brute force, as the magazine rifle is to the bow and arrow. There were certainly William Tells and Robin Hoods who could perform great feats with the ancient weapons, but every sane drover would pin his faith on the accurately sighted rifle when defending his flock against a pack of hungry wolves. In any factory there are plenty of wolves ready enough to eat up the profits.

Perhaps I may be excused if I use another analogy. In the present day a general in command of an army employs vastly different methods from those found effective in the days of the Crusades. He employs field telegraphs and telephones, observation balloons, railways, and many other modern inventions to control his various units, to keep touch with his enemy, and to bring forward his supplies; whereas it was no uncommon thing in the days of yore for the prince in command to plunge into the thick of the fight, and to help to win the victory with his own right arm.

In the factory, time was when the successful works manager took no thought of cost keeping, but paraded the shop with thumbs in the armholes of his waistcoat and bullied his men. The days of his success were the times when an engine sold for three times the price that one of similar size, yet more powerful, does today. It is considerably less than ten years ago that some of the largest engine-building factories in Great Britain first started cost keeping. Prior to that they could get practically their own prices, and as the banking account steadily swelled they knew they were all right and troubled not about detailed costs; it was not until banking matters began to change their appearance that such details as cost keeping received consideration. Times have changed and such selling prices will never again prevail; thus reduction in profits imperatively calls for reduced prime costs, and here it is that modern methods come in.

The keynotes of this management are *accurate information* and *system*. The old adage "Knowledge is power" is particularly applicable to a works manager, for, unless he has accurate knowledge of how everything is going, how can he put right that which is going wrong? The word "system" is apt to get hackneyed, and may perhaps convey a wrong impression to some minds unless we explain that to create a system is to provide a pre-arranged way for things to be done. A good system is, in comparison to a happy-go-lucky lack-of-system way of working, as a railway is to the prairie or veldt for travelling, and the smoothness and speed of running are in like comparison. A system, to be of value, must be as simple as is possible to obtain the object in view, and like the railway it should get there by the shortest route and have as few inclines as possible. It must, however, be remembered that a railway line may pay much better if it calls at several important towns en route. For instance, a cost-keeping system is primarily to obtain the total cost of the machine manufactured with a view to fixing a satisfactory selling price, but its value becomes immeasurably greater if en route it gives *detail costs* and also serves to indicate the *progress of work*.

These opening remarks may not at first sight appear to have much bearing upon the title of the paper, so it might perhaps be as well here to explain that in preparing the series of articles* of which this is the last, I had the following leading thought or problem in mind:—Given a factory in connection with which the profits have been a steadily diminishing quantity in spite of a fair share of trade; and upon a full consideration of the matter it is found that the plant is out of date, and it is decided to install modern rapid production machinery—what other steps are necessary to make the new plant a paying investment?

The first half of the solution of the problem lies in the answer that the machines must be properly equipped with tools to tackle their work, and the second half is embodied in the statement that they must be properly supplied with work for the tools to operate upon. Without either tools or work their value vanishes. In treatment of the first part of the problem, I have gone into the matter of draughtsmen to design the tools, tool room to make and prepare the tools, stores in which to keep them, and the means of indicating to the workman at the machine what tools are to be used. It is then the object of this article to make the last part clear, but the subject is more involved than at first sight appears, inasmuch as it strikes directly into important matters of management. Many kinds of high-class machine tools take a considerable time to set up for their work, but when in operation they do it with great speed. Suppose, for instance, a certain job takes two hours upon an old machine, but only ten minutes upon a rapid-production one, and that it takes two hours to set the tools on the latter. Obviously, it would make no reduction in cost to do a number of the articles in succession on the old machines, so they were made a few at a time as wanted; but with the modern machine, a big saving is effected by doing a number at once. If, then, there are many of these machines all requiring to do their work in batches, it makes a great difference in the methods of dealing with the work. The rough material, castings, forgings, or bars, must be supplied to the machines in quantities, altogether in a batch, and when finished, the work must be taken away and stored until wanted, leaving room at the machine for other work to be done. The whole thing seems simple enough, one might say—provide a stores for the rough material and another for the finished work. Not so simple, though, for the following reasons:

A.—Unless work is manufactured in quantities arranged by the management, stocks will be unduly inflated and too much money sunk in them, or bad stock made that may lie long unused.

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* THE ENGINEERING MAGAZINE, July and August, 1904.

B.—To ensure that the work shall be wanted in reasonable time, the parts that are stocked must be according to arranged standards.

C.—To ensure that parts when made shall be found correct when taken for use, they must be inspected when manufactured.

D.—As parts will require to be ordered and made in batches, instead of sets for the machines being manufactured, it will probably involve a re-arrangement of the system of ordering and of cost keeping.

E.—As the storing of parts, booking from stores to engines or machines, and cross booking in the cost books, would cause frequent reference to parts, it may be found advantageous to arrange some method of identification by symbols instead of by names.

It is obvious that a fairly strict hold must be kept on stocks by the management, as it is an easy thing in a large engineering establishment to get so much money sunk in stock as to cause financial tightness; on the other hand, if it is cut too fine it will mean manufacturing in small dabs, and frequent delays in executing orders consequent on stocks running out. The actual material and things to be kept in stock should be fixed by the works manager, who would naturally consult his head store keeper, and he should fix maximum and minimum quantities with due regard to the probable requirements of the works and the time it would take to replenish when re-ordering. The fixing of the quantities must be partly controlled also by the effect that quantity has upon economy of manufacture. The minimum quantity is that amount it is desirable to keep as a reserve, and when this minimum is approached or reached, the store keepers must order the quantity that would bring his stock up to the maximum beyond which he is not allowed to go. By fixing these quantities, the manager knows that the money sunk in stock cannot exceed the amount represented by the sum of the value of the maxima, and those who are responsible for the financing will know what they have to reckon with inside the works.

If it will take about three weeks to put through the works an order for the replenishing quantity of a given article, then the minimum quantity must be the average of about five-weeks demands on stores. Unless these quantities are definitely fixed by the management, the working of stores loses much of its value and it may result in a serious state of things. I know of a stores that was run upon very slack, not to say bad, lines. The stores keeper was under the control of the shop foreman, who himself was ignorant of stores operation. There was no attempt to book work either in or out of stores, the labour of booking being considered quite unnecessary and expensive; thus nothing in stores was accounted for, and work might be drawn by a man for a given machine or engine several times over without anyone being the wiser, or anything being charged against the machine for which it was issued. The making of work for stores was not upon any prearranged plan, and the stores keeper was not responsible for the quantities kept. A foreman, if wanting work, would walk into the stores, take a glance around, and then put in hand what quantity he chose of such article as he thought appeared to be running low, the quantity being regardless of the demands for the article. In this way expensive items, perhaps made of brass, would be there in sufficient numbers to last ten years, while others that did not catch the attention would be right out of stock. There is another danger in such casual methods as these; a workman getting hold of a job with a good price to it will run ahead and make an excessive quantity if the foreman is not sharp on him. And still again, there being no check on articles taken in and out of stores, a dishonest man would find it easy to draw articles therefrom to mix with those he was making, and get paid piece work for the lot.

It does not do to stock parts in quantity unless there is a steady demand for them, and to ensure that such shall be the case it is necessary to arrange standard lists of details. The work of standardisation is not easy in a factory where there has previously been but little thought or effort given to such a matter. Where there are no standard lists to work to, the draughtsmen each make the details of the machine they happen to be engaged upon to suit their own ideas or fancy. Thus it comes about that many details of a similar character, such as bolts, pins, bearings, journals, etc., will vary from one another in unimportant dimensions when identical details could be used. This kind of thing precludes effectual manufacturing, and to sort out these various details and scheme therefrom a straightforward progressive list of sizes to be used as standards, demands discriminating judgment. An ideal standard list will be so arranged that the succession of sizes advance by equal progressive steps, all dimensions being proportionate. In practice, however, these lists cannot always be so arranged, a compromise being sometimes necessary to meet various considerations. It is advisable when preparing the standard lists to make them as complete as possible, filling in the various steps of the series, even though not immediately wanted, the stores keeper being advised that these inserted sizes are not yet to be stocked. The object of this is to guide the draughtsmen in their designing, for should they require to include a detail as per standard, the list which gives all dimensions will guide them and prevent an irregular item being introduced.

Standard lists, when conveniently arranged, are extremely useful in all parts of the factory. The draughtsman has them to his hand that he may see what items he can depend upon being in stock; the stores keeper uses them in connection with his stock keeping, for it is convenient to have them marked with those items kept in stores; the piece-work or premium clerk uses them to mark prices or times upon; the workmen use them in making the parts, and the inspectors when viewing and trying work. A convenient size for the lists is about 13½ by 10 inches; they may be mounted on stout millboard and varnished for shop use, or bound in books for the offices.

The method of identifying parts is a matter of importance in all engineering workshops, and the way it is done may have a great effect in either the saving or losing of time. Most establishments are content to name the various machine parts, but this may easily lead to awkward mistakes from the simple fact that the parts are often left on the drawings without names, on account of the draughtsman's faculty for inventing in that direction having run dry. In those establishments how often drawings are marked "6 of this," or "10 of this," any semblance of name being entirely omitted. When that is so, the workmen often coin names for the parts, the name selected frequently having nothing to connect it with the article to be identified. I have found curious instances. Uncertain nomenclature is sure to lead to errors in details manufactured to orders, in cost keeping, and in bookings of various kinds; so a definite system of naming is imperative if accurate information is to be had and errors avoided. For the sake of certainty, lists of all parts in the machines or engines manufactured should be prepared, and against each of these names a number or identifying symbol should be placed. The lists of parts should be to all intents and purposes an idex, arranged with special consideration for ease of reference. These lists of parts can become order forms on which the draughtsman or the internal order department can specify the details required for particular machines. The opposite page shows part of such a list of details prepared by me for engine work.

To explain the method:—The main divisions or parts of the machine or engine are first taken, such main parts for instance as bedplates, cylinders, governors, valve gears, etc., being arranged alphabetically. Under these heads their component parts are next taken also in alphabetic order, and beneath these again the details of the parts are arranged, also in order. The section of the detail list reproduced will be seen to concern a throttle governor. This particular design of governor has certain components—bell-crank lever, casing, levers, sleeve, etc., and these are all in order as sub-components

SPECIFICATION FOR PROGRESSIVE ORDER No. ....

Identification Number.	Drawing No.	Quantity.	Description.	Order Ticket No.	Remarks.	£	s.	d.
16/2			**Throttle governor**					
16/4			" " **Bell crank lever**.........					
16/6			" " " " bracket					
16/8			" " " " fulcrum pin..					
16/10			" " " " washers					
16/12								
16/14								
16/16								
16/18								
16/20			" " **Casing**					
16/22			" " " door					
16/24			" " " " (special)					
16/26			" " " " sight door hinges					
16/28			" " " " sight door hinges pins..					
16/30			" " " tongue piece					
16/32			" " Centre pads. Standard list No.					
16/34			" " Centre pads. Standard list No.					
16/36								
16/38								
16/40			" " **Inertia lever**					
16/42			" " " " fulcrum pin.					
16/44			" " " " fulcrum pin washers ..					
16/46								
16/48			" " " " link ends ...					
16/50			" " " " link pin					
16/52			" " " " weights					
16/54			" " " " " bolts.					
16/56								
16/58								
16/60			" " **Levers**					
16/62			" " Lever fulcrum pins.......					
16/64			" " " weights					
16/66			" " " " bolts					
16/68			" " **Plate**					
16/70			" " " stop screws					
16/72			" " **Sleeve**					
16/74			" " " blocks					
16/76			" " " " pins					
16/78			" " " junk ring					
16/80			" " " ring (with or without trunnions) ..					

SPECIFICATION OR SCHEDULE OF PARTS, USED AS AN ORDER SHEET, DRAWING LIST, AND COST SHEET.

The gaps in the numbering are left for extensions or insertions. When the form has completed its work as an order sheet, a duplicate is sent to the cost office and the original to the stores, to assist in the accumulation of all details for the erectors or assemblers.

of the throttle governor. Each of these components has its details particularised immediately beneath it, so that any part is quickly found on the list. Thus to find a detail by name on the list—say the junk ring on the sleeve of a throttle governor, the main part of the engine—the throttle valve—is first turned to. In alphabetic position under this main part, the part of the governor—the sleeve—of which the detail is an item, is next found in heavy type, and immediately below that the junk ring, the detail in question, is found. Against each item of the list is an identification symbol in the form of a fractional number. The numerator of this fraction indicates the main part of the engine, say the throttle governor, and the denominator the particular detail of the governor. In the first preparation of such a list, only even numbers are used, all odd numbers being left for future use when adding items to the list. To complete the identification symbol, the type of machine or engine can be indicated by a capital letter such as M for a single-cylinder vertical open-type engine, and the size of the engine by a number; thus the symbol 6M 16/0 would be the complete throttle governor for No. 6 size single-cylinder vertical open-type engine, or again 6M 16/74 would mean the sleeve blocks for the same engine.

This method of identification can expand to an unlimited extent, and is a simple yet effective means of identifying all details, either on paper or in the concrete. Its further uses will become apparent later.

When the senior draughtsman responsible for the preparation of the drawing list is about to prepare such list for the works, he takes the printed identification list of the type of machine and fills the drawing numbers to each item in the column for that purpose, and he also marks the identification number on the drawing itself against the detail so that it cannot be misunderstood if several items are on the same sheet. The completed specification list with drawing numbers on is then handed to the individual or department handling the internal ordering, and a duplicate is prepared. This duplicate is for cost-keeping purposes, and has cash columns for the insertion of the total cost of each item. Before it is handed to the cost clerk, however, it is taken by the stores keeper, who marks against the items in stock the order numbers to which the said items were made. The list then returns to the order department, and the items not in stores are next ordered on the system in use in the establishment, the duplicate specification list with order numbers inserted going to the cost department to show them what is ordered, while the original list goes to the stores keeper to be retained by him until all parts are ready for the erector.

(To be continued.)

EDITORIAL COMMENT

THE return of the members of the Panama canal commission from the Isthmus, after a sojourn of two months, brings every assurance that the work is progressing as satisfactorily as could be expected, in view of the somewhat chaotic condition of affairs incident upon the unsettled condition of things during a number of years.

The work which was being maintained by the French company has been taken over by the commission, and is being carried forward more rapidly, although with a smaller force, than previously, and plans for the rapid extension and systematization of work along the whole line are being matured.

So far as the question of the employment of modern and special machinery is concerned, it is almost too soon to enable any very definite information to be obtained. A portion of the more recent equipment purchased from the French company will doubtless be found of use, but there is an immense accumulation of obsolete and useless machinery and material which is to be collected and sold for junk, thus getting it out of the way and making room for modern appliances.

The labor question has not yet reached a stage where it is open for public discussion, but it is well-known that numerous applications have been made for the supply of labor of various kinds and from various parts of the world. There is every reason to believe, however, that the quantity and character of labor required will differ materially from that which has hitherto been used, and that the introduction of improved and special methods of work will alter the nature of the problem to a great extent. It is more than probable that the question of the kind of labor to be employed will be modified as the work is conducted, and that experience with the problems as they are encountered will result in the designing of special appliances to enable power machinery to be used to the maximum degree. The opportunities for the provision of an ample supply of power along the entire route will aid materially executing such plans.

* * *

IT will be seen that such considerations effectually preclude the immediate announcement of any startling developments in connection with the great work at the Isthmus, and those who expect that the digging of the canal will be "begun" with a great flourish of trumpets and much speechifying will realize that something altogether different is already taking place. There is a very dirty house to be cleaned up, and a lot of useless junk to be disposed of; while at the same time the special appliances necessary for the proper conduct of the excavation and construction have to be both designed and constructed. That the canal is even now really being built is well understood by those who realize the extent to which sanitary and preliminary work forms a part of construction, while the general public may well be assured that this forms as essential a portion of the great undertaking as the digging of the cellar does in the building of a house.

WE have already referred to the manner in which the American Society for Testing Materials appears to have neglected the principal object for which the parent International Society for Testing Materials was formed, and this is a matter to which the attention of the engineering profession may well be directed. The original idea of forming such a society was that of unifying the methods of testing materials and of recording such tests to an extent which would enable the valuable work being done in all parts of the world to be strictly comparable. In addition to the accomplishment of this most desirable object, the International Society has taken up the questions connected with the conduct of such tests, studying the methods which give the most reliable results, and standardizing the practice of its members all over the world. In this most important undertaking the work of the Continental engineers has been extremely valuable, and it is most unfortunate that the American members have seen fit to neglect such associated international efforts. Since its formation the American society has practically become an organization for the discussion of materials of construction in a most general manner—a work entirely within the scope of the existing national societies with which most of the members are already affiliated, and for the conduct of which no new organization was needed.

* * *

MEANWHILE the subject of the unification of methods of testing, for the furtherance of which the Society was originally formed, has been almost entirely neglected, and any attempt to harmonize American practice with that of other countries has apparently been dropped. Various reasons have been advanced for this curious conduct, but it is unnecessary to discuss them in this place. The result cannot but be injurious to the scientific development of American engineering, and ultimately to American commerce in engineering products in other parts of the world, and it should be the duty of al American engineers who have the rea welfare of the profession at heart to bend their efforts to the correction of what, to put it in the mildest possible manner, has shown itself to be a distinct blunder.

* * *

THE review of the St. Louis Fair with which Mr. Bryan leads this number though necessarily brief in comparison with the field to be covered, gives a peculiarly clear and definite idea of the Exposition as an entity. This quality of singleness of conception will appear strikingly when his description is compared with other accounts approaching the subject from the viewpoint of the picturesque, the magnificent, or the sensational. The reason—or one reason —is that Mr. Bryan's study advance by the same steps as the project itself He reveals its structural lines, and s gives the key to the whole compositio and establishes plainly the relations o all its parts. In short, he shows tha the entire Exposition, from its first conception to its final detail, is a vas engineering problem, and that it demands and holds the attention not onl by what it houses and displays, but b what it is itself. And the truthfulnes of the representation is assured to th reader by the discriminating professional judgment and frank, even-hande justice with which Mr. Bryan distinguishes between the perfect and th imperfection in the work as a whole.

It is a real pleasure to be able to ad that from the financial point of view— necessarily one of anxious interest t very many of those most interested i the Exposition—the enterprise is i better condition than indications som time ago permitted its friends to hop

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE NEW THEORY OF MATTER.

PRESIDENTIAL ADDRESS AT THE CAMBRIDGE MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Right Hon. A. J. Balfour.

ALTHOUGH presidential addresses delivered before conventions of scientific societies are not always the most inspiriting reading they demand attention because of the eminence of the men by whom they are written and also because of the high character of the audiences to whom they are delivered. The British Association, as the name of the society is generally abbreviated, has had many eminent presidents, and among the thought inspiring addresses which have been delivered before it many will recall the famous Belfast address of Professor Tyndall, or more recently the review of the food problem of the world by Professor Crookes. At the present meeting the address was delivered by the Prime Minister, the Right Hon. A. J. Balfour, who called his remarks "reflections suggested by the new theory of matter," and naturally such a subject belongs rather to the domain of the physicist than the engineer, but the fundamental problems of engineering are based upon the researches of the physicist, and the two branches of science differ in degree rather than in kind.

After reviewing the general conceptions of the universe from the time of Newton down through the periods in which Young, Stokes, Maxwell, and their followers worked, Mr. Balfour takes up the modern theory of matter, the theory of electrons.

"Electricity was no more to the natural philosophers in the year 1700 than the hidden cause of an insignificant phenomenon. It was known, and had long been known, that such things as amber and glass could be made to attract light objects brought into their neighbourhood, yet it was about fifty years before the effects of electricity were perceived in the thunderstorms. It was about 100 years before it was detected in the form of current; it was about 120 years before it was connected with magnetism; about 170 years before it was connected with light and ethereal radiation.

"But to-day there are those who regard gross matter, the matter of everyday experience, as the mere appearance of which electricity is the physical basis; who think that the elementary atom of the chemist, itself far beyond the limits of direct perception, is but a connected system of monads or sub-atoms which are not electrified matter, but are electricity itself; that these systems differ in the number of monads which they contain, in their arrangement, and in their motion relative to each other and to the ether; that on these differences, and on these differences alone, depend the various qualities of what hitherto have been regarded as indivisible and elementary atoms; and that while in most cases these atomic systems may maintain their equilibrium for periods which, compared with such astronomical processes as the cooling of a sun, may seem almost eternal, they are not less obedient to the law of change than the everlasting heavens themselves.

"But if gross matter be a grouping of atoms, and if atoms be systems of electrical monads, what are these electrical monads? It may be, as Professor Larmor has suggested, they are but a modification of the universal ether, a modification roughly comparable to a knot in a medium which is inextensible, incomprehensible, and continuous. But whether this final unification be accepted or not, it is certain that these monads cannot be considered apart from the ether. It is on their interaction with the ether that their qualities depend; and without the ether an electric theory of matter is impossible.

"Surely we have here a very extraordinary revolution. Two centuries ago electricity seemed but a scientific toy. It is now thought by many to constitute the reality of which matter is but the sensible expression. It is but a century ago that the title of an ether to a place among the constituents of a universe was authentically established. It seems possible now that it may be the stuff out of which that universe is wholly built. Nor are the collateral inferences associated with this view of the physical world less surprising. It used, for example, to be thought that mass was an original property of matter, neither capable of explanation nor requiring it; in its nature essentially unchangeable, suffering neither augmentation nor diminution under the stress of any forces to which it could be subjected; unalterably attached to, or identified with, each material fragment, howsoever much that fragment might vary in its appearance, its bulk, its chemical, or its physical condition.

"But if the new theories be accepted these views must be revised. Mass is not only explicable, it is actually explained. So far from being an attribute of matter considered in itself, it is due, as I have said, to the relation between the electrical monads of which matter is composed and the ether in which they are bathed. So far from being unchangeable, it changes when moving at very high speeds, with every change in its velocity."

The internal forces which the new theory assumes to be in action within the atoms of matter form a far greater amount of energy than any which appears without these existing in undiminished activity when no external energy is apparent.

"In common, therefore, with all other living things, we seem to be practically concerned chiefly with the feeder forces of Nature, and with energy in its least powerful manifestations. Chemical affinity and cohesion are on this theory no more than the slight residual effects of the internal electrical forces which keep the atom in being. Gravitation, though it be the shaping force which concentrates nebulæ into organised systems of suns and satellites, is trifling compared with the attractions and repulsions with which we are familiar between electrically charged bodies; while these, again, sink into insignificance beside the attractions and repulsions between the electric monads themselves. The irregular molecular movements which constitute heat, on which the very possibility of organic life seems absolutely to hang, and in whose transformations applied science is at present so largely concerned, cannot rival the kinetic energy stored within the molecules themselves. This prodigious mechanism seems outside the range of our immediate interests. We live, so to speak, merely on its fringe. It has for us no promise of utilitarian value. It will not drive our mills; we cannot harness it to our trains. Yet not less on that account does it stir the intellectual imagination. The starry heavens have from time immemorial moved the worship or the wonder of mankind. But if the dust beneath our feet be indeed compounded of innumerable systems, whose elements are ever in the most rapid motion, yet retain through uncounted ages their equilibrium unshaken, we can hardly deny that the marvels we directly see are not more worthy of admiration than those which recent discoveries have enabled us dimly to surmise."

Notwithstanding the clearness with which Mr. Balfour presents the essentials of the electron theory it is evident that he regards it merely as one step further along the scientific highway of successive hypotheses, forming a passing element of an unending journey.

"The electric theory which we have been considering carries us into a new region altogether. It does not confine itself to accounting for the secondary qualities by the primary, or the behaviour of matter in bulk by the behavious of matter in atoms; it analyses matter, whether molar or molecular, into something which is not matter at all. The atom is now no more than the relatively vast theatre of operations in which minute monads perform their orderly evolutions; while the monads themselves are not regarded as units of matter, but as units of electricity; so that matter is not merely explained, but is explained away.

Now the point to which I desire to call attention is not to be sought in the great divergence between matter as thus conceived by the physicist and matter as the ordinary man supposes himself to know it, between matter as it is perceived and matter as it really is, but to the fact that the first of these two quite inconsistent views is wholly based on the second.

This is surely something of a paradox. We claim to found all our scientific opinions on experience; and the experience on which we found our theories of the physical universe is our sense-perception of that universe. That is experience; and in this region of belief there is no other. Yet the conclusions which thus profess to be entirely founded upon experience are to all appearance fundamentally opposed to it; our knowledge of reality is based upon illusion, and the very conceptions we use in describing to others, or in thinking of it ourselves, are abstracted from anthropomorphic fancies, which science forbids us to believe and Nature compels us to employ."

PRESENT PROBLEMS IN TECHNOLOGY.

ADDRESS BEFORE THE CIVIL ENGINEERING SECTION OF THE INTERNATIONAL CONGRESS OF ARTS AND SCIENCE AT ST. LOUIS.

Prof. Lewis M. Haupt.

DURING the past month there has been held in connection with the exposition at St. Louis the International Congress of Arts and Science, this great gathering representing the entire field of modern learning; the leading representatives of theoretical and applied sciences setting forth the general principles and fundamental conceptions connecting the various groups of sciences, reviewing the historical development of special sciences, showing their mutual relations and discussing their present problems.

Among the numerous papers of interest in connection with this important convention, we note that presented before the civil engineering section by Professor Lewis M. Haupt, treating of the present problems in technology, some abstract of which is here given. The scope of the subject is so vast that little more than a general view could possibly be given in the space allotted to a single address, but some of the salient points may be noticed.

In studying the relations of various elements in any department of science it is most desirable that sufficient data should be obtained from the past to enable a curve of progress to be plotted, and Professor Haupt endeavors to select and weigh the data to be used for this purpose in such a manner that the curve may safely be projected for a reasonable distance into the future.

The greatest difficulty encountered in this task is undoubtedly that due to the limitations of the human mind, and it is in its impotence and ignorance that the principal obstacles to the fuller knowledge of the laws of Nature are found. Only by thorough, unbiased research can the laws and facts of the physical world be interpreted and applied. Professor Haupt formulates a general law of development of the successive stages which mark the progress of great enterprises, with especial reference to the antagonistic forces which must be overcome before success can be achieved, showing that these resistances are psychological rather than physical, involving the operation of mind over matter.

The elements which enter into the solution of an engineering problem are more numerous than is generally supposed, including not only the technical training and the subsequent skill derived from experience, but also involving questions of finance, legislation, government, sociology, etc., so that the engineer must necessarily be familiar with the methods of the strategist in the arts of peace.

Taking up the question of transport as one of the great problems of the present day, it is shown that of the three media to be attacked, two, earth and water, have in large measure been placed under control. Prior to the early part of the last century all the efforts which had been expended upon the building of roads and the maintenance of communication failed to produce any great impress upon commerce and trade. With the introduction of railways, however, the span of a single life has witnessed a complete transformation, not only in methods of communication but in all the arts dependent upon the construction and maintenance of railroads. One of the pressing problems of the present, therefore, is that of the maintenance of an adequate supply of construction material to meet the demand at the increasing rate of requirement. Thus the single item of timber for cross ties leads to questions of irrigation and reforestation, since the demand for structural steel for other purposes renders it impracticable to use it for permanent way construction. Again the lack of timber for bridges and buildings has led to a great increase in the use of steel, while this demand again is being passed on to be supplied by the later method of reinforced-concrete construction, stone and masonry, in a modified form again asserting its old pre-eminence. In all these lines of work there are many pressing problems demanding solution and awaiting the efforts of the engineer. These questions of materials of construction, however, belong largely in the domain of the chemist and the physicist, whose relations to the work of the engineer are growing continually closer and more active.

Another great group of problems awaiting solution are those included in the generation and distribution of power. Originally derived mainly from the energy of falling water, the production of mechanical power received a great impetus with the invention of machinery for obtaining power from heat. This again drew upon the world's stock of stored energy in the form of wood fuel but the limitations of this supply retarded the progress of such machinery, and it was not until the development of the present coal supplies that the great expansion of power generating machinery became a reality. Now the problems under active study and work include the application of liquid and gaseous fuels, and the reduction of wastes and the utilization of by products.

In the mean time the progress which has been made in the electrical transmission of power, has brought once more into the field the great sources of natural water power, and these demand for their economical utilization numerous problems unknown in the older days of smaller units, lower heads, and slower speeds. It is possible that the energy of the waves and tides may yet be advantageously employed, but these are among the questions not yet commercially solved, although many attempts have been made.

Professor Haupt calls attention to the problems yet awaiting solution in the important domain of merchandise transport, in view of the enormous and constantly increasing tonnage.

"Here the problem has been, and still is to increase the ratio of live to dead load and to reduce the resistances by betterments in alignment, grade, distance, and terminal facilities, even at a large increase of capital. Still the delays in handling and drilling trains, composed of relatively small units and containing miscellaneous freights, in complicated yards, and the use of cars for many days for storage, necessitates great expense for which no adequate solution has been provided, although some relief may be obtained by the earliest possible transfer to waterways at the nearest practicable point, thus substituting the short for the long haul in some cases. In others, where bulky freight like ore, coal, or grain is handled, great improvements have been introduced, so that the entire contents of each car may be dumped through chutes into the hold of a vessel at one operation. The capacity of the car has also been increased, so that instead of the paying load being less than the weight of the carrier it is now about three times greater. Probably the greatest advance in economic transportation ever effected was that which revolutionized the movement of petroleum from the oil wells of Pennsylvania to tide water."

What the pipe lines have been to oil must some day be provided for other merchandise and for passengers, and the substitution of continuous for intermittent methods of transport is one of the present problems awaiting solution by the engineer.

The extension of navigation facilities forms another phase of the transport problem demanding attention. The limit of size, and hence of economy in vessels for water transport has been reached, not for constructive reasons but because of the limitations of harbor entrances. The greatest ports to-day provide insufficient depths for the largest modern vessels, and these are compelled to observe closely the periods of high water and run risks of grounding. Attemps to deepen channels by dredging material while leaving in action the forces which originally deposited that material, are but temporary expedients, and the engineer of the immediate future must accept the truth of the principle which utilizes the natural forces to scour out the channel and maintain its depth permanently.

Professor Haupt touches briefly upon the problems involved in the question of aerial transport, commending the efforts of the managers of the exposition to encourage experiments in this direction.

The magnitude of the problems at present confronting the engineer is indicated by the rate at which the population of the United States is increasing. By plotting a curve from data of recent and past records, it appears that by the year 1950 the country will have a population of 200,000,000, an increase of 260 per cent. and this within the lifetime of many of our contemporaries. With such an increase must come many new questions, but even without these the mere extension of requirements already known must demand the best efforts of the ablest minds in the engineering profession.

"But to be more specific as to the work before us, it may be said, that there is still great need for further improvement in the utilization and transmission of power of all kinds, both by movable and stationary engines;—in the application of natural forces to remove and prevent the formation of alluvial bars in commercial channels;—in the improvement and extension of better highways for the transportation of materials;—in the betterment and standardization of the rolling stock used in the conveyance of freight and passengers;—in the more general introduction of pneumatic plants for the distribution of the mails and for local deliveries in great cities, to reduce the congestion from the delivery wagons;—in the construction of subways for the installation of public-service conduits, sewers, water-supply, lighting, power, drainage, and interurban traffic;—in the original provision, in the planning of cities, for all classes of municipal service, prior to the establishment of new strategic commercial and populous centres;—in the timely equipment of existing towns, in anticipation of the rapid expansion of population, due to the compounding increment of growth;—in additional terminal facilities at points of trans-shipment, to avoid delays and demurrage in port;—in continued efforts to attain practical results in aeronautics;—and in many other special branches of technology, too numerous to mention.

THE MANUFACTURE OF STEEL CASTINGS.

HISTORY, DEVELOPMENT AND PRESENT PRACTICE OF THE ART OF MAKING STRUCTURAL MACHINE ELEMENTS OF STEEL CASTINGS

B. Osann—Stahl und Eisen.

THE growth in the use of steel castings for machine construction has been a notable element in mechanical progress during recent years, and it is a curious fact that in spite of the importance of subject but little available information exists as to its practical technology. For this reason the papers of Professor Bernhard Osann, in recent issues of *Stahl und Eisen* form a welcome contribution to the literature of the subject, and demand review at length. The remarkable display of steel castings at the recent Düsseldorf exposition furnish numerous illustrations of what has been done in this department of work, and add materially to the value of the papers.

Attempts to make steel castings followed close upon the development of the open-hearth process, but the difficulties in the way caused progress to be slow at first. About 1872 attempts were made to cast screw propellers in steel, and gradually sufficient experience with the practical details was acquired, so that after about ten years the use of steel casting for machine parts began to meet with approval, and at the present time, and especially since the development of the electrical industries, the material has come into most extended use. Indeed, it is fair to say that without the ability to use steel castings the present development in machine construction would have been impossible. Cast-iron, while useful for many purposes, is of but limited application, because of its low tensile strength, brittleness, variability, and low elasticity, while forgings of iron or steel are debarred from many uses, both because of the prohibitory cost and because of the impracticability of forming it into the arregular shapes possible with a material which can be cast in a mould. Doubtless the development which has been made in the use of steel castings is largely due to the demands which have thus been made for a material which should have the good properties of both materials and the defects of neither.

Among the early difficulties encountered in the use of steel castings, the most troublesome were the frequent occurrence of blow holes, the appearance of hot and cold cracks, and the problems of shrinkage, but as a matter of fact these are really the same questions which should be considered in connection with cast iron, except that their greater frequency and extent with steel has made them more conspicuous.

In making steel castings the influence of the high temperature at which the metal is poured upon the refractory material of the mould must be taken into account. This requires great care to be exercised in the selection of the sand and clay for the mould and corresponding precautions in drying and baking. Such moulds necessarily offer a greater resistance to the shrinkage of the casting, and since the shrinkage of steel is much greater than that of cast iron, frequently more than twice as much, cracks are formed in the hot metal as it solidifies, these being called hot cracks in distinction from cold cracks which appear in the finished casting.

The tendency to form blow holes may also be traced to the great shrinkage of the steel, and hence the best method of prevention is to provide ample facility for the mass of the metal to follow the movement of contraction. This is done by providing a number of risers at the points where the best connection with the body of the mould can be effected, besides furnishing a much more liberal sinker head than would be considered necessary for cast iron. By such means, as well as the use of proper precautions to prevent the exterior from cooling too rapidly, the blow holes may be prevented.

A most important portion of the work in the production of satisfactory steel castings, however, must be done, not in the foundry, but by the designer in the preparation of the form and character of the piece to be cast. In this department of the work the same general considerations hold good as in the foundry. The great extent of the contraction of the metal, sometimes as much as 3/8 of an inch to the foot, or more than 3 per cent. of its length, must always be kept in mind. It is evident that unequal shrinkage will lead to the formation of cold cracks and cause internal strains, while uniform shrinkage, even if great in total amount, will not produce these effects. It is therefore most important to design the work in such a manner as to avoid great variations in the masses of metal, keeping uniformity of section as much as possible.

By distributing the material in the form of thin plates, reinforced by ribs of the same thickness, and adopting cellular construction for the parts where the greatest strength is necessary it is altogether possible to permit the various parts to be kept at nearly the same temperature during the operation of casting and cooling, so that shrinkage strains and cracks may be almost entirely avoided. It is also important that sharp corners and angles are avoided, large fillets and easy curves being employed, since any sharp angle partakes of the nature of a nick and forms a ready point for the origin of a crack. It is not too much to say that a large part of the success which has been attained in the use of steel castings has been the result of the education of draughtsmen and designers at these points, while much of the trouble has been due to the neglect of just such sumple precautions.

In the manufacture of steel castings it is important that care be taken in the character of the metal. Especially is it important that the phosphorus, sulphur, and copper be present only in the smallest quantities, and it is only with the best material that the best work can be expected.

Professor Osann illustrates his papers with illustrations showing a number of important steel castings, these including stern posts and rudder frames for large vessels, bed plates for marine engines, heavy gearing, dynamo frames, armatures, and details, besides numerous portions of machines of all kinds many of these having formed portions of exhibits at Düsseldorf. These include pieces from less than a pound in weight up to 50 tons or more, forming examples of actual work, and not merely produced for exhibition purposes, and fully demonstrating the extent to which steel castings are being applied in practical engineering work.

NAVAL BOILERS.

FINAL REPORT OF THE ADMIRALTY COMMITTEE UPON DESIGNS OF STEAM BOILERS FOR USE IN THE ROYAL NAVY.

Engineering.

WE have reviewed at length in these columns the interim reports of the special committee appointed by the Admiralty for the purpose of considering the best forms of boilers for naval service, and now we have the final report of the same committee, which has been officially given to the public. In a recent issue of *Engineering* there are some interesting comments upon the report, and we take occasion to discuss both the report and the comments together.

It will be remembered that the occasion for the appointment of the committee was the dissatisfaction prevalent with the performance of the Belleville water-tube boilers which had been installed in certain important vessels, this dissatisfaction developing into a discussion of the relative merits of water-tube and cylindrical boilers for naval service. The committee, consisting of a number of eminent engineers of acknowledged fairness and freedom from prejudice, has gone about its work with painstaking thoroughness, making experimental trials with vessels equipped with various kinds of boilers, and studying the conditions with much care.

The results of these investigations resulted in the decision that the Belleville boiler was unsuited for use in the Navy, but it was also decided that the cylindrical boiler was not satisfactory, but that some form of water-tube boiler should be used. It was temporarily determined that four types of water-tube boiler should be selected for further use in combination with cylindrical boilers, these being the Babcock and Wilcox, the Niclausse, the Dürr, and the large-tube form of the Yarrow boiler. The final report modifies this decision to the extent of authorizing but two of the above mentioned boilers, the Babcock and Wilcox and the Yarrow, and further permits these to be employed for the entire equipment of a vessel, without the association with cylindrical boilers. This portion of the report may be given intact.

Having concluded their experimental investigations, the Committee are now satisfied that two of these four types—viz., the Babcock and Wilcox, similar to that tried in the Hermes and the Yarrow large-tube, similar to that tried in Medea—are satisfactory, and are suitable for use in battleships and cruisers without cylindrical boilers. In the Babcock and Wilcox boiler the generating-tubes are nearly horizontal; in the Yarrow boiler they are nearly vertical. Each type has its particular advantages, and only long experience on general service can show which is, on the whole, the better boiler. For the present the Committee unanimously recommend both types as suitable for naval requirements.

In making these recommendations, the Committee recognise that the upkeep of any water-tube boiler is likely to be heavier than that of the cylindrical boiler; but they are of opinion that the two types they now recommend will cost less for upkeep than the other types of large straight-tube boiler which they have had under trial.

The Committee make these recommendations after investigations and trials carried out under their superintendence extending over a period of nearly four years.

The ships in which each type of boiler has been tried by the Committee are:—
Cylindrical:—H.M.S. Minerva and R.M.S. Saxonia.

Belleville:—H.M.S. Diadem and H.M.S. Hyacinth.

Babcock and Wilcox:—H.M.S. Sheldrake, H.M.S. Espiègle, and H.M.S. Hermes.

Niclausse:—H.M.S. Seagull and H.M.S. Fantôme.

Dürr:—H.M.S. Medusa.

Yarrow large-tube:—H.M.S. Medea.

Although the Committee have no knowledge of any type of water-tube boiler which is likely to prove more suitable for His Majesty's ships than the two recommended, there are other types which may be considered worthy of trial later on. If any type of boiler is considered, in future, to be of sufficient merit to justify its trial in the Navy, it is recommended that it be fitted in a new vessel not smaller than a second-class cruiser.

As in their previous reports, the Committee do not offer any remarks upon the most suitable type of boiler for small vessels of high speed. From the nature of the case, some form of "express" boiler, with small tubes closely pitched, is absolutely necessary, in order to obtain such a ratio of output to weight of boiler as is required in torpedo-boats and destroyers. For small cruisers, however, which have to keep the sea and act with the fleet, it is probable that a boiler such as the Yarrow large-tube would, on the whole, give better results than the "express" types which have hitherto been fitted.

Commenting on these and other features of the report, *Engineering* says:

The report states that the Yarrow and the Babcock and Wilcox boiler have each its particular advantages, and that which is the better boiler can only be determined by long experience on general service. Certain details are, however, given, and by means of them engineers may, perhaps, be able to form more definite opinions of their own. In the first place, the Committee recognise that the upkeep of any water-tube boiler is likely to be heavier than that of the cylindrical boiler. That may be the case at the present time; but it is possible that when further experience has been gained, the cost of upkeep may be very materially reduced, both in regard to making the boilers more durable—weak features being discovered and eliminated—and by improved and cheaper methods of effecting repairs. The cylindrical boiler has a very long start in this respect. As matters stand, we think it probable that some of the members of the Committee may have been influenced by their experience with boilers of the mercantile marine, and have used this as a standard of comparison. If we were to compare the cost of upkeep of the present water-tube boiler of the best type with that of the Navy return-tube boilers—which it superseded—we doubt whether the debit balance would be always against the water-tube type. It is true that the desire to save weight had at one time led to cylindrical Navy boilers having their tubes crowded together and reduced in diameter to a dangerous extent, thus increasing the chance of breakdown and adding to the cost of repairs; but it is necessary to consider the whole question, and if we take the comparatively modern cylindrical boilers of the Minerva and compare them with those of the Cunard liner Saxonia, we find that, weight for weight, the former generated more than twice as much steam as the latter.

An interesting feature in connection with the investigations of the Committee is that relating to the expansion and contraction of the tubes. It has been felt that possibly the effects of expansion might be injurious in boilers in which the tubes were rigidly fastened at both ends. and for this reason the Niclausse and the Dürr boilers, in which the tubes are secured at but one end, permitting free expansion, were at first included. It was evident, however, that this construction was not so advantageous as at first appeared, since these boilers showed numerous bent tubes in service, and were not so capable of being forced as the other types. It is possible that these facts were due to the inability of the internal tubes or partitions to maintain the water in active circulation, and in any case it is evident that having the tubes free at one end does not insure immunity from bending.

One point which has been made against water-tube boilers in general is the great care required to fire them properly. The report, while admitting this fact, shows it to be of minor importance, since good firing was readily obtained during the trials made by the Committee: On this point *Engineer-*

ing makes the following pertinent remarks:

"Skilled firing, we know, is needed to get the most economical results with water-tube boilers, but that, we consider, is not altogether a defect for warship practice. The need for higher intelligence and adequate training is the distinguishing feature of the modern navy. It is no advantage, but rather a danger, for a considerable part of the *personnel* to consist of crude and uninstructed men. If a stoker cannot fire a water-tube boiler—and there is no special magic about it—he should have no place on board a man-of-war. Our constant effort should be to raise the status in every department, and necessity tends to this end. The report states, however, that 'good results can be obtained from Yarrow boilers with engine-room complements new to the ship.' That may be true of these boilers, but they should never be put to the test, if we translate 'new to the ship' as 'new to that kind of ship.'"

Broadly, the report is a very satisfactory document, in that it establishes the fact that the water-tube type of boiler is the best for naval service and that it is unnecessary to couple it with any cylindrical boilers as reserve or auxiliary. The water-tube boiler has established itself on land, and it will doubtless secure as sure a position afloat. Experience will undoubtedly cause improvements to be made and new types will probably compete for admission into the naval service, but in any case we may accept the fact that the day of the cylindrical boiler as the standard in naval vessels is past.

TECHNOLOGY AND MANUFACTURING.

THE INFLUENCE OF SCIENTIFIC ORGANIZATION AND SYSTEMATIC METHODS OF DESIGN UPON ECONOMY IN THE WORKSHOP.

F. A. Neuhaus—Verein Deutscher Ingenieure.

ONE of the interesting features in the development of modern engineering is found in the closer relations which exist between the methods of the designing engineer and those of the workmen in the shop; leading to concessions on both sides, to the great advantage of the business side of the establishment. Formerly the engineer worked out his plans with little attention to the methods by which they were to be executed, and much time and effort were wasted in the shop in carrying out details which had but little influence upon the commercial value of the finished product. Now, however, all this is changed, and the man who makes the plans for the work which is to be done in the shop is expected to be familiar with the methods of manufacture to such an extent as to permit the execution of his ideas to be accomplished to the greatest advantage.

In a paper presented before the Berlin section of the Verein Deutscher Ingenieure, and published in a recent issue of the *Zeitschrift* of the Society, by Herr F. A. Neuhaus, this phase of engineering work is discussed in a very effective manner. Herr Neuhaus is especially well qualified to speak with authority, being himself the director of one of the most important machine works in Germany, besides having had a wide experience with American methods during an extended residence in the United States.

The scientifically trained engineer naturally endeavors to give his work the proportions which are indicated by the forces under consideration, by the strength of the materials employed, and by the mechanical movements involved, but there is no reason why these may not be included in connection with the most advantageous methods of manufacture.

An important obstacle to the maintenance of a systematic method of machine design, emphasised by Herr Neuhaus, is the continual demand of customers for changes to be made in the products to suit their own ideas. Formerly this difficulty existed to a great extent in the United States, but the best establishments in nearly all lines of work now decline to make any alterations in their standard machines, or else make such high charges for changes as to deter the customer from insisting. As a matter of fact, the needs of the customer have generally been so fully studied by the designer that he may well be considered the best judge in the case, and in most instances this view of the matter may tactfully be impressed upon the purchaser. In the United States this reform has gone so far that in some cases an establishment produces but a single type of machine, and even but one definite size of tool, but these represent extremes which cannot be generally expected.

To carry out properly the idea of the consideration of shop methods in connection with machine design involves also the wide subject of technical education. The designing engineer who has not had practical experience in the shop cannot be expected to bear in his mind the demands of shop requirements to their widest extent, however fully he may desire to do so. It is only by the combination of theoretical knowledge and practical workshop training that the best results can be expected, and to this end much attention should be given in connection with technical education.

Herr Neuhaus compares the difference between the German and the American drawing room, showing how the latter is equipped with data and information concerning the shop standards and sizes, with accepted proportions of standard parts, screw threads, gauges, etc., the designers and draughtsmen being expected to keep these always in mind in their work. Instead of dimensioning parts to the exact sizes demanded by computation, the nearest shop size is used, the range of sizes, and consequently of tools, gauges, jigs, etc., being correspondingly limited. The question of the dimensions of cylindrical parts is cited as bearing especially upon this matter. These are classified according to operation, into running, standing, and forcing fits, according as the journal is to revolve, remain stationary, or be forced into place by hydraulic or screw pressure. The use of limit gauges is included in this matter, and instead of leaving the allowances to the shop, the draughtsman is provided with the proper information, and required to arrange his work accordingly.

Another point which, when properly considered, makes a material difference in the cost of machining, is found in the selection of the curves for fillets on finished work. Thus the engineer who draws a parabolic curve uniting the body of a connecting rod with the stub end knows perfectly well that this will require much time and care for its reproduction in metal, while if he ascertains the diameters of the available milling cutters with which the work can be done, he can choose such a radius as will permit the tool itself to finish the work accurately to size without difficulty or loss of time.

Again, in the design of a series of products, such, for example, as a line of steam engines, the engineer who takes the shop work into account will so arrange his dimensions that a number of parts will serve for more than one size of machine, waiving strict exactness for an average proportion which will cut down the number of variations in size to about one-half what might otherwise be made.

The question of accessibility to working and adjustable parts is one which is too often neglected by the theoretical engineer who has not been there himself, so to speak. Nuts which are used for making adjustments demand room for the wrench to swing through the proper angle without having the skin knocked off the knuckles of the operator. Engine housings should be made with sufficient openings to permit complete access to the bearings, crank pins, and other working parts, while the provisions for lubrication demand similar experienced forethought. The writer well remembers a design for a saw for cutting off hot metal, the regulating handles of which were so arranged that the operator was obliged to lean over the bar of hot metal in such close proximity as to scorch his clothing; and yet this machine was designed by a man of reputation, who failed to perceive that the circle on paper representing the cross section of the bar of metal meant a mass of metal at a red heat.

Herr Neuhaus comments on the difference in engine details in vertical and horizontal engines when the parts fulfil practically the same functions. Thus in the case of vertical engines there appears a general use of framing composed of turned wrought-iron pillars; also forked connecting rods are in evidence, with one-sided slipper-guide cross heads. Horizontal engines, however, are rarely so made, even when constructed by the same firms, and the idea of using the same connecting rod and cross-head for a vertical and a horizontal engine, would be regarded as rank heresy, in Germany, at least.

These are but a few of the points made in this most interesting paper, but they will serve to illustrate the importance of combining technical and practical knowledge on the part of the designing engineer if the products of his ingenuity are to be made commercially successful. When competition was less strenuous than at the present time it might have been possible for the plans for shop work to be made in independence of the means by which they were to be executed, but that time is long since past, and the successful engineer of to-day must keep in close touch with the men and the methods to be employed in the execution of his designs. A close observation of the requirements of both machinist and customer, together with a keen appreciation of the advantages of mass production, repetition work, and the fullest use of modern shop facilities, these must be united to brilliant inventive faculties and thorough technical training, if full success is to be attained.

DIRIGIBLE BALLOONS.

METHODS OF BALANCING AND MAINTAINING STABILITY IN MECHANICALLY PROPELLED AND GUIDED BALLOONS AT HIGH SPPEDS.

Col. Ch. Renard—Académie des Sciences.

AMONG the earnest workers in the field of aerial navigation the name of Col. Renard is well known, he having made some of the earliest experiments which showed any degree of success in propelling and guiding balloons; and his dirigible balloon, *La France,* constructed in 1884, demonstrated the ultimate possibility of making such machines successful when motors of sufficient lightness and power should be provided. This machine contained many of the elements which have to-day been found essential, including the cigar shaped gas bag, with the greatest diameter in advance of the middle of its length, the rudder being placed in the rear and the propeller at the front end, but the weight of the electric motor and batteries made high powering impracticable, and hence the balloon was not able to be operated against strong winds. Since that date the great advance which has been made in the construction of light-weight internal-combustion motors has made it possible to give sufficient power to such machines to make them much more effective, and thus modern experimenters are again working on the lines laid down by Col. Renard twenty years ago.

In these columns we have noticed at different times various communications which have been made upon these subjects by this veteran experimenter, and we now have a communication made by him to the French Academy, and published in *Comptes Rendus*, bearing upon the important question of the maintainance of the stability of dirigible balloons, a matter which has shown itself to be a serious one when high speeds are attempted.

The experiments of Santos-Dumont and others have proved what is also indicated by theory, that for balloons of symmetrical form there is a critical speed beyond which violent pitching occurs, and as this critical speed is the relative speed of the balloon as compared with the surrounding air, it may be attained by reason of a head wind, even when the actual velocity of the machine is low.

There is no doubt that many disasters have been due to the lack of stability which thus occurs, and one of the most important questions to be solved in connection with aerial navigation is the matter of balancing and the maintenance of stable equilibrium at all times.

In his present communication Col. Renard maintains that the true principle of construction in this respect is similar to that which appears in the arrow. An arrow flies through the air toward its mark without pitching or oscillations because the heavy head concentrates the greater portion of impelling energy in the part forward of the centre of gravity, while at the same time the feathers guide and hold back the rear portion and act to steady the whole. By using a long gas bag of comparatively small diameter, with the propeller placed at the front end, pulling, as it were, instead of pushing the machine through the air, the first step toward stability is attained, and to this arrangement, Col. Renard proposes to add the equivalent of the feathers in the arrow, and thus give the apparatus satisfactory stability at any speed which may occur in practice.

The method of "feathering" proposed by Col. Renard consists in the addition, on each side of the gas bag, at the rear portion, of short cylinders of smaller diameter than the main envelope, these cylinders to be made of the same fabric as the gas bag and to be inflated with air. He also proposes to place the *ballonet,* or part of the main balloon which is inflated with air to keep the whole in a taut condition, in the rear part, these modifications providing a retarding effect upon this part of the machine, and causing it to oppose the pull of the propeller at the front in such a manner as to reproduce the steadying effect of the feathers on the arrow.

Various modifications of this ingenious arrangement are given, and groups of smaller guiding cylinders in twos and fours are sketched, and the computations for the proportions to insure satisfactory stability are shown to be simple and conclusive. The whole forms another of the important contributions which have been made by Col. Renard to the subject of practical aeronautics, and we may expect to see it applied in practice by succeeding experimenters.

In this connection it is interesting to note that Col. Renard is himself not such an enthusiastic advocate of the dirigible balloon as he once was, the improvements in light and powerful motors having led him to turn his attention to the possibility of making a successful machine both lifted and propelled by screws. It appears, however, that still greater advances in motor construction must be made before this plan can be considered available, although it is probable that a toy machine could even now be made in this way. When the problems of balancing and propulsion in connection with the development of the aeroplane, are solved, we may look more confidently in that direction for ultimate success.

It must be remembered that even a machine which possesses in itself the elements of success must be operated by those skilled in the difficult balancing which is evidently necessary. The clumsy flapping of the young bird, just pushed over the edge of the nest by its experienced mother, shows us that something more than instinct is necessary, even for the bird, and surely we may expect that as much practice may be required for flight as is needed to learn to ride a bicycle, for example.

It is possible that a combination of the aeroplane with the dirigible balloon might form a machine in which the management of the former could be learned while under the kindly support of the latter, much as the timid beginner learns to swim by the aid of an air belt, the support being gradually withdrawn as the experience is gained. The two machines may yet be combined into one structure, the supporting force of the gas bag relieving only a portion of the total weight, and leaving the balance to be provided by the planes of the aeroplane. It is evident that in any case the machine alone will not be sufficient, but that experience in operation must be added, and some method of gaining this experience appears to be an essential element in final success.

The solution of the problem of aerial navigation, carrying with it, as it does, the control of such important matters as the conduct of warfare and the liberation of international commerce, demands much more serious scientific treatment than has hitherto been given to it. Instead of the sporadic experimental work which has been possible by the efforts of a few unaided individuals, the matter should be considered as one to be attacked by a continual series of experiments, directed by the best scientific ability, under the auspices of the most powerful civilized nations.

In this way, and probably in this way alone, can the repetition of useless and disastrous trials be avoided, while the united efforts of the scientific and industrial world will be brought to bear upon the problem. Such are the methods which have been used in the application of engineering to machinery of warfare and destruction, and there is no good reason why they should not be applied to a matter of at least equal importance to mankind.

THE DEVELOPMENT OF INVENTION.

THE RELATION OF THE DEVELOPMENT AND PROTECTION OF MECHANICAL INVENTIONS TO HUMAN WELFARE.

Hon. C. A. Parsons—British Association for the Advancement of Science.

IN the course of his address before the Engineering Section of the British Association for the Advancement of Science, the President of the section, Hon. C. A. Parsons, brought out some interesting points in connection with the nature of the protection which he believes should be given to aid in the development of engineering inventions.

Referring to the ordinary conception of invention as that of a happy thought occurring to an inventive mind, Mr. Parsons shows the erroneous nature of such an idea, and maintains that what is usually called an invention is the work of many individuals, each one adding something to the work of his predecessors, each one suggesting something to overcome some difficulty, trying many things, testing them when possible, rejecting the failures, retaining the best, and, by a process of gradual selection, arriving at the most perfect method of accomplishing the end in view.

"Then, after the invention, which we will suppose is the successful attempt to unravel some secret of Nature, or some mechanical or other problem, there follows in many cases the perfecting of the invention for general use, the realisation of the advance or its introduction commercially; this after work often involves as great difficulties and requires for its accomplishment as great a measure of skill as the invention itself. of which it may in many cases be considered as forming a part."

In order to explain his views more fully, Mr. Parsons takes the case of the development of an invention of which we have the full history, and reviews the progress of the internal-combustion motor as an example of the growth of the machine from the early conceptions to its present commanding position.

"The first true internal-combustion engine was undoubtedly the cannon, and the use in it of combustible powder for giving energy to the shot is strictly analogous to the use of the explosive mixture of gas or oil and air as at present in use in all internal-combustion engines; thus the first internal-combustion engine depended on the combination of a chemical discovery and a mechanical invention—the invention of gunpowder and the invention of the cannon.

"In 1680 Huygens proposed to use gunpowder for obtaining motive power in an engine. Papin, in 1690, continued Huygens' experiments, but without success. These two inventors, instead of following the method of burning the powder under pressure, as in the cannon, adopted, in ignorance of thermodynamic laws, an erroneous course. They exploded a small quantity of gunpowder in a large vessel with escape-valves, which, after the explosion, caused a partial vacuum to remain in the vessel. This partial vacuum was then used to actuate a piston or engine and perform useful work.

"We come a century later to the first real gas-engine. Street, in 1794, proposed the use of vapour of turpentine in an engine on methods closely analogous to those successfully adopted in the Lenoir gas-engine of eighty years later, or thirty years ago. But Street's engine failed from crude and faulty construction. Brown, in 1823, tried Huygens' vacuum method, using fuel to expand air instead of gunpowder; but he also failed, probably on account of the wastefulness of the method.

"Wright, in 1833, made a really good gas-engine, having many of the essential features of some of the gas-engines of the present day, such as separate gas and water-pumps, and water-jacketed cylinder and piston.

"Barnett, in 1839, further improved on Wright's design, and made the greatest advance of any worker in gas-engines. He added the fundamental improvements of compression of the explosive mixture before combustion, and he devised means of lighting the mixture under pressure, and his engine conformed closely to the present-day practice as regards fundamental details. No doubt Barnett's engine, so perfect in principle, deserved commercial success; but either his mechanical skill or his financial resources were inadequate to the task, and the character of the patents would seem to favour this conclusion, both as regards Barnett and other workers at this period. Up to 1850 the workers were few, but as time went on they gradually increased in numbers; attention had been attracted to the subject, and men with great powers and resources appear to have taken the problem in hand. Among these numerous workers came Lenoir, in 1860, who, adopting the inferior type of non-compression engine, made it a commercial success by his superior mechanical skill and resources. This stage of the development being reached, the names of Siemens, Beau de Rochas, Otto Simon, Dugald Clerk, Priestman, Daimler, Dowson, Mond, and others, appear as inventors who have worked at and added something to perfect the internal-combustion engine and its fuel, and who have helped to bring it to its present state of perfection.

"In the history of great mechanical inventions there is, perhaps, no better example of the interdependence of the engineer, the physicist, and the chemist than is evinced in the perfecting of the gas-engine. The physicist and the chemist together determine the behaviour of the gaseous fuel, basing their theory on data obtained from the experimental engines constructed by the mechanical engineer, who, guided by their theories, makes his designs and improvements; then, again, from the results of the improvements fresh data are collected, and the theory further advanced, and so on till success is reached. But though I have spoken of the physicist, the chemist, and the engineer as separate persons, it more generally occurs that they are rolled into one, or, at most two, individuals, and that it is indispensable that each worker should have some considerable knowledge of all the sciences involved to be able to act his part successfully.

Reviewing this series of inventions and labors, Mr. Parsons maintains that the length of time required for the development of the engine from the primitive beginnings might have been materially abridged had the Patent Office undertaken for the successive inventors the searches which would have informed them of what had been done before, similar to what is done in the United States and in Germany. The absence of this knowledge also frequently acts as a deterrent to business men, preventing them from embarking in the exploitation of an invention from the fear of the appearance of an anticipation.

The point upon which Mr. Parsons makes the strongest argument, however, is the fact that the present brief duration of a patent is a positive barrier to the development of some very important undertakings which might well otherwise be accomplished.

Thus the successful solution of the problem of aerial navigation demands more time than could be obtained under the existing patent laws.

"This problem could undoubtedly be successfully solved by an organised attack of skilled and properly-trained engineers and the expenditure of a large sum of money. Assuming the problem solved, and commercially successful, it appears to be impossible under the existing patent laws to secure any adequate monopoly so as to justify the expectation of a reasonable return on the capital, expended on the invention. For in view of the multitude of suggestions that have been made and the experiments that have been carried out, the practical solution of the problem would appear to rest on a judicious selection of old ideas by means of exhaustive experiments."

Another illustration, of which much has been said in the newspapers, is the possibility of making a borehole of several miles in depth, for purposes of geological investigation, an undertaking which could well be accomplished if protection in the form of a monopoly for a sufficient length of time could be secured. As it is tersely put:

"At the present time there is no adequate protection, or, indeed, any protection at all for the promoters of many great and important pioneer enterprises, some of which might prove of immense benefit to mankind."

The remedy which Mr. Parsons has to suggest for this state of affairs is that of an extension of the duration of the life of patents, making this variable according to the subject matter of the invention, or possibly according to the amount of money which the promoters might pledge themselves to spend within a certain time for the development of the project. Such a plan would also involve international cooperation, in order to prevent to throwing open of a patent abroad while it still remained a monopoly at home.

While there is much to be considered in these propositions it is a question whether the world at large would be benefited by any extensive lengthening of the life of patent monopoly for inventions. The experience with the tenure of land has shown that when ample time is given the owner, secure in his title, will often await the work of others to improve the surroundings before he himself will do anything, and in the United States there has recently appeared a disposition to juggle the patent law so as to defer the issue of inventions for many years, until the work of industrious inventors and manufacturers has shown it to be time to release the old invention upon those who have really done the work.

It is the general experience that the expiration of a patent is the signal for a sudden development in that department of industry, if the invention is of any value, and since it is to stimulate just such a development that the original monopoly is granted, any such extension of time would cause the invention to become obsolete before giving it to the public. The greatest business enterprises in the world have grown up without other monopoly grants than those which the commercial ability of the projectors has been able to create, and these will generally be forthcoming when the inducement offered is sufficient.

HYDRAULIC LIFT LOCKS.

THE NEW HYDRAULIC LIFT LOCK ON THE TRENT CANAL AT PETERBOROUGH, ONTARIO.

J. M. Bulkley—Engineering Record.

CANALS have many advantages as routes for the economical transport of merchandize, but they are limited by one positive requirement, the necessity for maintaining a level surface; there can be no grades on a canal. The use of locks to overcome the differences of level between the various portions of a canal is a very ancient method, but it is limited in the range of elevation which can be surmounted by a single lift, so that a number of locks are required when the height is great. Numerous plans have been devised as substitutes for the old-fashioned canal lock, these including inclined planes, up which the boat is hauled; cylindrical tanks, in which the boats can be rolled up-hill, pneumatic lifts, hydraulic lifts, screw lifts, and a variety of modifications of these plans.

The first hydraulic lift for canal use in America has just been completed at Peterborough, in Canada, and from a description by Mr. John McClelland Bulkley in a recent issue of the *Engineering Record* we give some account of a system which has been found to possess many advantages.

"Like many engineering projects of magnitude, the lift lock has been perfected by a process of evolution. The pioneer lock was built at Anderton, England, and connects a local system of canals with the River Weaver, serving principally the carriage of products from salt works in the vicinity. The lift at this dock is about 50 feet, but its barge capacity is relatively small, the chambers being only 70 feet long by 14 feet wide. No receiving pit was provided, the chambers discharging directly into the river. Pumps were also used to assist in taking the load. The construction is of plate girder design. In France the second lock was built, at Les Fontinettes. It is of moderate dimensions, the canals of the district being only 17 feet wide. The third lock is at La Louviere, in Belgium, on the Canal du Centre, and is of the truss girder pattern. These locks have been more or less successful, and while the operation showed conclusively that the principle of a hydraulic lift lock is a correct one, defects were apparent that could be avoided in the construction of other locks.

"The special functions of the Peterborough lock are, first, to overcome the elevation; second, to reduce the time in which this duty is to be performed; third, to furnish ample capacity for a given number of lockages or the maximum quantity of tons to be handled, avoiding a congested traffic. The question for the Department of Railways and Canals to decide was whether the lift should be overcome by locks of the ordinary type, or by such a form as that under consideration. If of the ordinary type, then at least five locks would be required. When these were in use, boats and barges would have to wait until the five lockages had been effected before gaining access. To avoid such delay the locks would have been built in pairs, as is the case at Lockport, on the Erie Canal. The cost of these ten locks would have far exceeded the outlay for the hydraulic lock. The time of lockage would have been a serious hindrance to traffic, the attendance a very serious item, and the service would have been slower, continually interrupted, and the capacity of the canal at this point restricted. Hydraulic lift locks are planned and built to serve the future as well as the present and to provide for expansion."

The principle of the lift lock is extremely simple, it consisting merely of two tanks placed side by side and supported on plungers working in hydraulic cylinders. The two cylinders are connected by a pipe so that water can flow from one to the other, and when one plunger, with its tank, is at the top of its stroke, the other is at the bottom, the two tanks balancing each other. Since the boat displaces exactly its own weight of water, the balance is maintained when boats are in the tanks just the same as when they are filled with water, the water being at the same level in both. The proper excess of water being run into the upper tank it descends, forcing the other one to ascend, and this action is repeated whenever a boat is to be raised or lowered. At Peterborough the lift is 65 feet, and this elevation is to be surmounted in about 3 minutes, giving a great gain in time, saving of water, and increase in capacity over the old system of successive chamber locks in series.

In the construction of such a system there are many details which render the undertaking a difficult one, in spite of the simplicity of the principle. The great plungers are 90 inches in diameter, built up of sections of cast iron, while the cylinders, of steel, stand a working pressure of 600 pounds per square inch. The tanks are carried on double cantilever trusses, and the whole is erected upon massive masonry foundations, with guide towers and walls. The joints between the tanks and the gates which close the ends are made tight by a packing of rubber sealing tubes, these being inflated by an air pressure of ten pounds per square inch, this effectually preventing the escape of water, a similar packing being used on the gates which close the ends of the canal reaches.

"An ordinary lockage will be conducted in this manner: Suppose 100 tons of 'surcharge' has been found to give sufficient additional weight to the descending chamber. The uppermost chamber will then be required to stop with its floor 8¼ inches lower than the bottom of the upper reach. On communication being established between it and the reach it will receive from the reach 100 tons more than the lower chamber contains, assuming the depth in both reaches to be the same. Then the total operations to form the lockage, assuming that the gates adjoining the reaches are open and that the seal tubes between the chambers and reaches are inflated, will consist in hauling the vessel into the chamber and mooring her there securely, closing the gates, deflating the seal tubes, and opening the main valve between the presses. The heavier chamber will commence to descend, the motion being allowed to increase gradually by the gradual opening of the valve, until it reaches the maximum speed. At about three quarters of the stroke the main valve is slowly closed, communication between the presses being entirely cut off when the end of the journey is reached. The change in elevation being made, the seal tubes are inflated, the gates are opened, and the vessel or vessels are free to go on their journey, after being towed out by the capstans. The surcharge contained in the descending chamber simply flows out into the lower reach, while a similar quantity to perform the next lockage is admitted into the chamber which has just reached the higher elevation.

"The advantages claimed for the hydraulic lock over those of the ordinary type are saving of time, economy of water and increased capacity. With reference to capacity, it will be noticed that vessels traveling in opposite directions may be locked through simultaneously."

SINGLE-PHASE ELECTRIC TRACTION.

PRACTICAL OPERATION OF SINGLE-PHASE ELECTRIC MOTORS ON THE BALLSTON DIVISION OF THE SCHENECTADY RAILWAY.

Electrical World and Engineer.

WE have already referred in these columns to the rapid development which is being made in the application of single-phase motors to electric traction, and this is further emphasised by the success which has been attained by the General Electric Company in connection with the operation of the Ballston Division of the Schenectady Railway. Recently a demonstration of the operation of the car thus equipped was made before a visiting party of engineers, and from an account of the equipment given by the *Electrical World and Engineer* we make some abstract and review.

"The motor is of the commutator type, possesses the true series characteristics, and it operates equally well with direct or alternating current. In mechanical construction the motor differs from the direct-current machine only as regards the field structure, the armature core, winding and commutator, being essentially equivalent to what is considered best design in direct-current traction motor practice, a four-polar wave winding suitable for operation with two brushes. As applied to the motor in question, the brushes are of standard width and size, and the holders are permanently fixed at the neutral position. The width of air-gap adopted is about twice that employed with stationary induction motors of corresponding size. The field core has no projecting poles, but is built up of laminated rings with distributed slots in which are placed windings similar in many respects to those used with two-phase induction motors, one phase winding, however, containing several times as many turns as the other.

"The machine belongs to that class designated as 'compensated series' motors. This term, as ordinarily applied, refers to those motors in which the inductance of either the field or armature winding is neutralized by counter current in an additional winding placed in inductive relation to the corresponding coil. In this class falls the motor whose field inductance is counteracted by a short-circuiting connection through brushes on the commutator in line with the field magnetism, the current induced in the secondary brush circuit when the armature is stationary being in phase opposition to the current in the field coils. This class includes also that type of motor which uses a short-circuited coil placed upon the field core in an inductive position with respect to the armature winding and in which the current produced by transformer action opposes in magnetomotive force the armature current and thus nullifies more or less completely the active inductance of the armature. The type which the General Electric Company uses differs from the latter in that the current in the compensating coil, instead of being produced inductively, is caused to flow therein on account of the fact that the compensating coil is connected in series (opposition) in the main motor circuit. Thus the compensation in this third type may be designated as 'forced' in distinction to that of the other two types, which is 'induced.'"

The armature, field, and compensating circuits of the General Electric motor are connected in series. If the effective turns of the compensating coil be equal to those of the armature, the resultant inductance of the two will be represented by the small leakage effect of the magnetism around the individual turns of each coil and will be practically negligible, so that, if the inductance of the field coil be made small, the total inductance of the motor circuits will be correspondingly small and the power factor at any operative speed will be relatively high. While in the induced type of compensated motor the secondary current can never quite equal the primary in magnetomotive force, in the forced compensation type the compensating coil can be given any value of magnetomotive force relative to the armature and the machine may be over compensated if desired, certain detrimental effects being produced, however, when the compensation is excessive.

"Such a motor is well adapted to operation by direct current, the commutation being practically perfect on account of the fact that the field distorting effect of the armature magnetomotive force is balanced by the magnetomotive force of the compensating coil when the turns on each are properly related. The compensating circuits of the machine being in all respects equivalent to the balancing coils on the early Ryan type of non-sparking, direct-current is beyond criticism and for alter-commutating tips are not required for holding the field magnetism in the proper mechanical position. The service tests demonstarted that the commutation for direct current is beyond criticism and for alte-nating current it is satisfactory."

An important feature in the line at Schenectady is found in the overhead work, this being arranged to permit the car to be operated over the same tracks as others using the continuous current.

"The direct-current trolley and feeder conductors have not been disturbed. Over 11.6 miles of the 15.5 miles between Schenectady and Ballston additional No. 4-0 wires were strung and fed at one point with 25 cycles alternating current at 2,200 volts. Upon the regular center poles spaced 100 ft. apart were placed 5-ft. cross arms, holding on each end high-potential porcelain insulators, similar to the ones used on transmission circuits. On these insulators were strung two ⅜-in. steel cables, from which were suspended the high-potential trolley wires clipped to the steel cables midway between the poles. While this catenary construction is exceptionally flexible and gives the best of insulation to the high-potential conductors, it is believed that, where only alternating-current wires are used, standard trolley line construction as now employed with direct-current equipments will prove entirely adequate."

The arrangement of placing the line at the side of the car, with a low-running trolley is also applicable to the conversion of steam railways to electric traction, since the wires are not exposed to the action of the discharge gases from locomotives, and the whole comes well within the limits of the railway loading gauge.

Comparative trials with alternating and continuous current on the same line show practically no difference as regards maintenance of speed and ease of control. Average speeds of 32 miles per hour were maintained in both cases, the car starting from rest equally well with either system, and the test of practical service has been impartially applied.

While these results are of great interest and value as regards the introduction of the alternating current into street railway service, they have a still more important bearing upon the far wider problem of the replacement of steam by electricity on main-line railways. It is practically admitted that the continuous-current systems are not well adapted for long-distance railway service, besides which the enormous cost of replacing the motive power plant has operated as a bar to the consideration of the subject by railway officials. If, however, it is made possible for the short-haul business to be operated by electric traction over the main lines, without interfering with the steam haulage of the freight and through trains, the opportunity is afforded for the gradual replacement of the one system by the other, the steam machinery being discarded as it is worn out, without requiring any immediate and wholesale scrapping.

A very important feature of the electric system is the possibility of running the railway cars upon the street-railway tracks of the cities, and delivering the passengers at any desired point, instead of dumping them out at a station to find their way about as best they may. As we have pointed out more than once in these columns, the real running time for the passenger is measured between his own terminals, and it avails him but little for the train to make a high speed when he has to waste much time to make the connections at the terminals. When a man can take a trolley car at his own door and be carried directly through the streets, out on to the main line, and finally into the streets of the city of his destination, much of the rush and hurry and inconvenience of railway travel will be avoided, and the day of the overgrown nuisance known as the union railway station in our great cities will be over. The ponderous train, hauled between one great terminal and another, was the natural outcome of the use of the steam locomotive, but the release from this system appears to be in sight.

THE CONSTITUTION OF PORTLAND CEMENT.

RESULTS OF THE MICROSCOPIC EXAMINATION OF PORTLAND CEMENT CLINKER CONSIDERED AS A SOLID SOLUTION.

Clifford Richardson—Association of Portland Cement Manufacturers.

THE whole study of metallic alloys has been revolutionized by the application of the microscope, and the science of metallography, derived from that of petrography, or the study of rocks, is now firmly established. An extension, or rather a reversion, of this method has now been applied to non-metallic substances, and the result is a new theory of the constitution of Portland cement, considered from a physico-chemical standpoint. This theory has been presented in a very complete manner in a paper presented at the Atlantic City meeting of the Association of Portland Cement Manufacturers, and from a reprint of this paper in the pages of the *Engineering Record*, we make some abstracts.

The use of the microscope in such investigations is based upon the theory that it is not only the chemical composition of a material which determines its properties, but that the physical arrangements of the constituents also has an important influence upon its behaviour. In the case of metallic alloys it has been found that the physical constitution can be studied by polishing the surface and then etching it with acid or other suitable material, the arrangement of the structure then becoming readily apparent under a proper degree of magnification. In the case of rocks, cement clinker, and similar materials, it is found better to prepare transparent sections by grinding the piece down until the transmission of light becomes possible, the structure then becoming plainly visible under the microscope. In such studies the use of polarized light is of great value, the methods being practically the same for cement as have already been employed with success in the examination of rock sections.

"Among the theories advanced as to the constitution of Portland cement there are those which assume the presence of certain so-called silico-aluminates, such as $2SoO_2 Al_2O_3 6CaO$ and others of less basic form. All of these proposed compounds have been prepared by the writer and found not to be definite chemical compounds, nor to correspond in any way with any of the mineral entities found in industrial clinker. They are in fact only solid solutions, of aluminates in silicates, of indefinite structure.

"This brings us to the point where the nature of a solution, especially of solid solutions, must be taken up.

"Solutions may be defined as the merging of two or more substances in one another in such a way that it is impossible to recognize them by any physical means. In this respect they differ from the elements and definite chemical compounds. The elements cannot be or have not been differentiated by any chemical or physical means into other substances. Definite chemical compounds can be differentiated by chemical means into their constituent elements, but at the same time are always composed of these elements in a definite mathematical ratio, involving only whole numbers and depending upon the combining weight of each element.

"Mixtures of gases, gases dissolved in liquids, liquids which are mixed together and salts dissolved in liquids are types of solutions. In the preceding paragraph mention has been made of solid solutions. We owe our conception of such solutions to Van't Hoff, a Dutch chemist, who, in 1890, having observed some abnormal features in the behavior of certain solutions of solids in liquids when they were frozen, was led to believe that the solid which separates on freezing is not the pure solvent, but a mixture of the solid solvent and the dissolved substance forming a solid solution. Investigations have proved that the conception was justified. Roozeboom has shown from a study of mixtures of fused salts that on cooling solid solutions are often formed, especially if the salts have the same crystalline form and habit.

"The constitution of our igneous rocks may best be explained by considering them as solid solutions, which, when the original liquid magma, from which they are derived, is cooled to a temperature at which freezing sets in, are formed by the crystallization of such mineral species as the constution of the magma may permit, and which we recognize as quartz, mica, felspar, etc., the composition of which, while in approximately definite proportions, is more or less modified by the substances which they may retain in solution."

The old theory of Portland cement considered it as a true chemical compound, a silico-aluminate, but Mr. Richardson decided to investigate the subject upon the theory that, in a parallel manner to the iron-carbon alloys constituting steel, Portland cement might be a solution of some aluminate in a tri-calcic silicate.

"The problem was approached in the following manner: Clinkers were made from pure chemicals, silica, alumina and lime, in the proportions found in industrial clinker. In order to obtain these proportions it was necessary to determine what the molecular ratios between silica, alumina and its chemical equivalent, iron oxide, and lime and its chemical equivalents, the magnesia and alkalies, were. Fortunately there are in existence two very exact analyses of industrial clinker which will serve for the purpose. If, in these analyses, the weight per cent. of each constituent is divided by the molecular weight of this constituent, that is to say, by its combining number, the quotient will give the relative number of molecules of the different substances in the clinker. It is also possible by adding the molecular proportions of alumina and iron together and of all the bases together, to discover the relation of silica, alumina and iron oxides, these being known as R_2O_3 bases, but here acting as acids, and the lime and other bases, known as the MO bases, to each other and by dividing each of these ratios by such a figure as will maks that for silica equal to 1.0 to express this still more simply. It is also possible from these ratios to calculate, by multiplying them by the atomic weight of silica, alumina and lime, the proportions by weight and the precentages of each of these materials which it is necessary to use in order to produce a pure clinker having the same basicity and molecular ratio as the industrial clinker, but in which the unessential elements are absent. In this process, however, it is necessary to deduct the amount of lime which is present in combination with sulphuric acid, as this plays no part in the formation of the clinker."

Mr. Richardson goes into the proportions of the various elements of cement clinker very fully, and the reader must be referred to the original paper for the tabulated results of his researches. It is sufficient to state here that the microscopic examination fully confirms the solution theory, and makes clear a number of points which were unexplained by the chemical theory.

By studying the physical constitution of various clinkers the effect of temperatures of burning, rates of cooling, and fineness of grinding may be determined very closely, and a comparison of the appearance of the clinker with the actual behaviour of the product made a means of improvement of the product, or a repetition of certain desirable properties.

There has been much controversy and disagreement among makers and users of cements as to the relative values of different grades and kinds, and there has been a tendency to rely upon chemical composition or method of manufacture in the determination of the various grades. It is evident that the true method is that advocated by Mr. Richardson, and that henceforth the microscope will become the criterion of character and value with cement as with steel.

It is apparent that no one method of study or system of examination should be considered sufficient for any material of construction, as there is no logical reason for assuming that the strength bears any definite relation to the chemical composition, to the physical structure, or to any one selected class of properties which it may be found convenient to observe. We have grown so accustomed to the idea that because certain substances are alike in some respects they are alike in all others, that it is hard to realize that this may not be so, but experience is teaching the observant engineer that he should exhaust every means which science has placed at his disposal for the study of the materials with which his work must be done. It is only by such care and thoroughness that rational methods can be developed to replace the older empirical ones.

THE BEHAVIOUR OF STEEL UNDER VIBRATION.

PRELIMINARY NOTES ON THE FRACTURE OF STRUCTURAL STEEL UNDER ALTERNATING STRESSES.

Prof. J. O. Arnold—British Association for the Advancement of Science.

AMONG the important papers presented before the recent meeting of the British Association for the Advancement of Science we may call especial attention to one read before the Engineering Section by Professor J. O. Arnold upon the question of the fracture of structural steel under alternating stresses.

"The efforts of steel metallurgists and engineers to obtain scientific control over the mechanical properties of steel for structural engineering purposes, although attended with much success, have nevertheless presented certain unfortunate features of failure. Thirty or forty years ago it was claimed, apparently with reason, that if the chemical constituents of mild steels were identical their mechanical properties were necessarily similar. But, as experience extended, it soon became evident that steels registering practically the same chemical analyses gave astoundingly different mechanical tests.

"The next stage of research led to the enunciation of the generally accepted idea that steels having a good chemical composition, correlated with satisfactory tensile and bending tests, were thoroughly reliable. But the advent of high speeds placed engine parts under rapidly alternating tensile and compression stresses, the reversals being in some instances at the rate of 800 per minute. Under these new conditions the sense of security ensured by a good chemical composition and satisfactory static tests was rudely disturbed by the fact that steel, in a relatively small number of cases was liable to fracture far below its elastic limit, more after the manner of glass than of a ductile metal."

It was in consequence of just such anomalies as these that attention was drawn to the value of the microscopic method of studying the physical properties of steel, and by the methods of metallography much has been learned about the relations of chemical and physical constitution upon the resistance of the metal. Professor Arnold admits, however, that after fifteen years of research, the microscope has failed to solve the mystery of steel in this particular matter.

The importance of this question will appear when it is understood that the problem is the determination of the cause and prevention of the failure of steels, normally possessing great toughness and ductility, when these are subjected to continuous vibration and alternation of stresses. These are the actual working conditions existing in very many important structures, and the failure in actual service may mean great loss both of life and property, so that the problem possesses great importance, both from a scientific and economic point of view.

As an example in the subject Professor Arnold cites the failure under the hydraulic test, of a boiler plate, which when subjected to chemical analysis and to the testing machine gave entirely satisfactory results. Under the microscope the structure showed a distinct and unusually sharp segregation of the pearlite and ferrite, the latter being angular and intensely crystallized. It was also large in pattern and frequently occurred in those long white lines rich in sulphur and phosphorus, which are technically known as "ghosts." It was at first thought that the sharp crystallisation might be regarded as an effect due to the causes which also produced the effect of brittleness, but this opinion was decisively negatived by subsequent experiments.

In order to investigate the subject further Professor Arnold has constructed at Sheffield University College a special form of testing machine for subjecting the test piece to severe alternating stresses, slightly beyond the elastic limit. The present machine, which is a preliminary one, records the number of vibrations, which can be varied at will, but in a future series of tests it is intended that a record shall also be made of the energy expended per test piece, by means of a delicate integrating wattmeter.

This method of testing, which practically carries out the almost impracticable Wöhler test in one or two minutes, has already thrown important light on the obscure phenomena under investigation, and has exhibited remarkable delicacy. At the present time the results obtained appear to warrant Professor Arnold in making certain preliminary statements.

"In preliminary tests on standard English acid open-hearth boiler-plate steel the remarkable fact was noted that in all probability *the resistance of structural steel to rupture under rapidly alternating stresses is inversely proportional to the rate of alternation.* This law, if fully established by the exhaustive experiments now being carried on at the Sheffield College, demands careful attention from every engine designer."

Professor Arnold tabulates some of his results, showing the data upon which he bases these conclusions, and also calls attention to the manner in which certain erratic results were explained by the assumption that one side of the plate under test was brittle and the other tough, a matter now under investigation. Experiments upon attempts to remove the brittleness caused by alternating stresses by annealing revealed some curious results. In the first place it appears that when a steel has assumed decisive brittleness in alternation it cannot be restored by heat treatment of any kind short of remelting. The injury to this especial steel was on one side of the plate, and hence was due to unskilful re-heating of the ingot and not to an improper casting temperature, since the latter must necessarily have affected every portion of the plate. Further, it appears that the microstructures of specimens both of the brittle and the tough steels, were in all respects identical, though that of each pair varied with the heat treatment to which they had been subjected.

Professor Arnold further discusses some investigations made by him upon a test piece of mild steel, bent to a radius of about two feet, so that the outer side was subjected to a marked tension and the inner to compression. Such a piece, subjected to alternations of 266 per minute, showed that, in regard to resistance to fracture, the portion of the plate in tension was inferior to that in compression, while the steel about the neutral line was superior to that next to the inner radius.

These experimental investigations, of which the present report is but a preliminary one, appear to be of much importance, and when completed will doubtless furnish reliable data of great value to the designing engineer. The fact that they have been undertaken by such a man as Professor Arnold, in the course of the work of the mechanical laboratory of the Sheffield College, demonstrates the usefulness of such a laboratory, and proves that such an institution may be made of much more use than the mere repetition of well-known phenomena for the instruction of students. There is no doubt that instruction and research may be carried along together to the joint benefit of the students and the engineering profession at large, and in this respect Professor Arnold has demonstrated, not only some important facts with regard to the behaviour of steel, but also as to the right use of the facilities which have been placed at his disposal.

In this connection the results which have been shown as to the injurious influence of alternating stresses upon materials of construction should emphasize the importance of avoiding such stresses whenever possible. In this respect the growing interest in machines operating solely by continuous motion, such as steam turbines, centrifugal pumps, rotary blowers, etc., is of importance, and it may be that the true way of preventing the dangers from alternating stresses is to strike the evil at its source and adopt, whenever possible, such designs in which reciprocating and alternating motions, especially at high speeds, may be abandoned.

Already the difficulties of dealing with the forces occurring in connection with rapidly alternating movements have been encountered by the engineer, and the questions of counterbalancing repicrocating masses and the prevention of excessive vibration have for some time formed the subject of study and experiment. When to these are added the internal stresses and weakening effects shown by Professor Arnold, it is apparent that there are many good reasons for using pure rotary motion.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

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(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 125
ELECTRICAL ENGINEERING 132
INDUSTRIAL ECONOMY 138
MARINE AND NAVAL ENGINEERING.... 138
MECHANICAL ENGINEERING 140
MINING AND METALLURGY............ 147
RAILWAY ENGINEERING 152
STREET AND ELECTRIC RAILWAYS...... 155

CIVIL ENGINEERING

BRIDGES.

Amsterdam.

The Operation of the New Bridge over the Amstel at Amsterdam (Bewegingsinrichtingen der Nieuwe Amstelbrug te Amsterdam). F. C. Dufour. With illustrations of the new arched bridge, and details of the operation of the double bascule draw span. 3500 w. De Ingenieur—June 11, 1904. No. 64475 D.

Arch.

The Bridge over the Syra Valley at Plauen in Voigtland (Die Syratalbrücke in Plauen i. V.) H. Fleck. A detailed account of the construction of a highway bridge at Plauen near Leipzig. The single masonry arch is of 90 metres span. Two articles. 2500 w. Deutsche Bauzeitung—July 16, 20, 1904. No. 64440 each B.

Design of a Fixed-Ended Arched-Rib Highway Bridge. Prof. Chas. Derleth, Jr. Calculations, stress sheets and general drawings for a steel bridge which was one of the designs submitted for a bridge to Goat Island, Niagara River. 2 Plates. 6000 w. Cal Jour of Tech—May, 1904. No. 64635 C.

Bascule.

The Division Street Bascule Bridge, Chicago. Description of bridge, with illustration, and of the operation of each leaf independently by electric motors. 800 w. Eng Rec—Aug. 20, 1904. No. 64501.

Concrete.

The New Concrete Arch Bridge over the Etsch at Forst (Die Neue Gewölbte Betonbrucke über die Etsch bei Forst). C. Haberkalt. Describing a concrete arch with hinges at the springings, 31 metres span over the Etsch in the Tyrol. 2500 w. 2 plates. Oesterr Wochenschr f d Oeff Baudienst—July 2, 1904. No. 64471 D.

Drawbridge.

Replacing a Double-Track Drawbridge. Illustrated description of the new bridge across the Menominee River, at Milwaukee, Wis. 2000 w. Eng Rec—July 30, 1904. No. 64180.

Ferry Bridges.

Flying Ferries. Novel Bridge Construction. General description of transporter, or ferry, bridges, and of those over the Manchester Ship Canal and the Mersey River and over the Usk, at Newport, Monmouthshire. 1200 w. Ir & Steel Trds Jour—Aug. 6, 1904. No. 64694 A.

Suspension Ferry over the Loire River at Nantes, France. B. H. Ridgely. Brief illustrated description of ferry or transfer bridges at Nantes and at Newport, England. 1000 w. R R Gaz—Vol. XXXVII, No. 11. No. 64625.

Fraser River.

The Erection of the 232-Foot Triangular Span of the Fraser River Bridge. Illustrated description of erection of the unique spread span of the double-deck railroad and highway bridge at New Wesminster, B. C. 1800 w. Eng Rec—Aug. 13, 1904. No. 64398.

Girders.

Principles of an Analytical Theory of the Action of External Forces on a Continuous Girder (Grundlage für eine Analytische Theorie der Aeusseren Kräfte der Kontinuierlichen Träger). Nikolaus v. Szüts. A mathematical investigation, taking into account the resistance of the piers to bending. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—July 15, 1904. No. 64414 D.

The Continuous Girder upon Elastic Yielding Piers (Der Durchgehende Träger auf Elastisch Senkbaren Stützen). L. Geusen. A graphical examination of the distribution of forces in a continuous girder when the supports are not rigid. 1800 w. Zeitschr d Ver Deutscher Ing—July 23, 1904. No. 64404 D.

Newburyport.

The Merrimac River Bridge at Newburyport. Illustrated description of highway bridge with four fixed spans and one draw span. The large cylinders for piers were grouted in place by air pressure. Also, editorial. 3500 w. Eng Rec—Aug. 20, 1904. No. 64504.

Reinforced Concrete.

A Skew-Span Double-Track 54-Foot Reinforced Concrete Arch. Describes a bridge in progress at Jackson St., Newark, N. J., for carrying the two main tracks of the Central Railroad of New Jersey. 2000 w. Eng Rec—Aug. 16, 1904. No. 64282.

Concrete-Steel Bridges at Dayton, O. Photographs and drawings with data showing the details of construction for two similar bridges. 2800 w. Munic Engng—Aug., 1904. No. 64262 C.

Suspension Bridges.

Theory and Formulas for the Analytical Computation of a Three-Span Suspension Bridge with Braced Cable. Leon S. Moisseiff. Mathematical discussion and diagrams. 5 Plates. 5000 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64585 E.

A Rational Form of Stiffened Suspension Bridge. Gustav Lindenthal. Showing the advantages of this form, and describing particularly the Manhattan Bridge over the East River, New York. Illustrations and diagrams. 3 Plates. 2500 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64584 E.

General Methods for the Calculation of Statically Indeterminate Bridges, as Used in the Check Calculations of Designs for the Manhattan Bridge and the Blackwell's Island Bridge, New York. Frank H. Cilley. Mathematical discussion, with diagrams. 8000 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64583 E.

A Light 510-Foot Suspension Bridge. Illustrates and describes a bridge across the Kanawha valley, near Coperton, W. Va. 2000 w. Eng Rec—Aug. 6, 1904. No. 64284.

Sydney.

Sydney Harbour Bridge. Illustrated description of designs submitted for a bridge with a main span of 1,350 ft., 170 ft. above the water, and a total length of 3,000 ft. 3000 w. Engr, Lond—Aug. 12, 1904. No. 64526 A.

Trestles.

Pile and Timber Trestle Bridges on the Santa Fé. Extracts and illustrations from paper by A. F. Robinson in Bulletin No. 53 of the American Railway Engineering and Maintenance of Way Association. 2200 w. R R Gaz—Vol. XXXVII, No. 9. No. 64380.

Viaduct.

The Avignon Viaduct. Daniel Bellet. Illustrated detailed description of a viaduct connecting two stations on the Paris-Lyons-Mediterranean Railway, at Avignon. 1000 w. Trac & Trans—Aug., 1904. No. 64349 E.

Vienna.

The Rebuilding of the High Bridge over the "Tiefen Graben" in Vienna (Der Umbau der Hohen Brücke über den Tiefen Graben in Wien). Karl Christl. Illustrated description of a viaduct carrying an important city street over an old depressed quarter. 2000 w. 3 plates. Oesterr Wochenschr f d Oeff Baudienst—June 11, 1904. No. 64466 D.

CONSTRUCTION.

Building Collapse.

The Collapse of a Building During Construction. Discussion on paper by H. de B. Parsons on the Hotel Darlington disaster in New York. 10000 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64586 E.

Building Construction.

The New York "Times" Building. An illustrated account of the new building at Broadway and 42nd Street, New York. 2500 w. Stevens Ind—July, 1904. No. 64343 D.

Concrete Surfaces.

Facing and Finishing Exposed Concrete Surfaces. Extracts from a forthcoming book on "Reinforced Concrete" by A. W. Buel and Charles S. Hill. 6000 w. Eng News—Aug. 25, 1904. No. 64608.

Dams.

An Earth Dam with Loam Core, at Clinton, Mass. Illustrated description of the south dike of the Wachusett Reservoir, 3,000 ft. long, 620 ft. wide and 60 ft. high. Serial. 1st part. 1800 w. Eng Rec—Aug. 20, 1904. No. 64510.

Concrete Dam and Concrete Steel Subway for Walter Baker & Company, Limited. Drawings and description of interesting concrete work. 1500 w. Eng Rec—Aug. 6, 1904. No. 64278.

Lake Cheeseman, Dam and Reservoir. Discussion on paper by Charles L. Harrison and Silas H. Woodard. 9000 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64591 E.

The Gatun Dam. Discussion on paper by C. D. Ward on a dam for controlling the Chagres River, Panama. 1600 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64589 E.

Earth Pressures.

Lateral Earth Pressures and Related Phenomena. Discussion on paper by E. P. Goodrich. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64590 E.

Embankment.

Highway Embankment Across Tidal Flats at Lynn, Mass. Illustrated description of a pleasure highway across the tidal flats and marshes near the mouth of the Saugus River, which requires an embankment averaging 12 or 13 feet in height. 1800 w. Eng Rec—Aug. 6, 1904. No. 64281.

Fireproof Construction.

Lessons of the Baltimore Fire. Abstract of an address by Capt. J. S. Sewell, Corps of Engineers, U. S. A., before Nat'l Board of Fire Underwriters, particularly on the construction of buildings so as to protect them against fire from outside. 2000 w. Eng Rec—Aug. 20, 1904. No. 64505.

The Effects of the Baltimore Fire. W. N. Hazen. General discussion of the effects of this great fire on the buildings, fireproof and otherwise, with illustrations. 6500 w. Pro Engrs' Soc of W Pa—May, 1904. No. 64631 D.

Reinforced Concrete.

A Statical Investigation of a Curved Prismatic Body of Reinforced Concrete (Statische Untersuchung eines Einfach Gekrummten, Stabförmigen Verbundkörpers). Prof. Ramisch. A mathematical study showing the action of forces to effect bending. 3500 w. Oesterr Wochenschr f d Oeff Baudienst—July 9, 1904. No. 64472 D.

A Study of the Properties of Reinforced Concrete (Een Onderzoek naar de Eigenschappen van Gwapend Beton). A. C. C. G. van Hemert. Describing tests upon reinforced concrete beams, with determinations of coefficients for various combinations. 7500 w. De Ingenieur—June 4, 1904. No. 64474 D.

Reinforced Concrete Construction in a Commercial Sand Plant. Illustrates and describes the interesting features of a plant at New Brighton, Staten Island. 3300 w. Eng Rec—July 30, 1904. Serial. 1st part. No. 64179.

Tests of Reinforced Concrete Beams. Prof. Arthur N. Talbot. Illustrated paper before the American Society for Testing Materials, giving description and results of tests made at the University of Illinois. Table: Diagrams. 4000 w. Eng News—Aug. 11, 1904. Also, Eng Rec—Aug. 13, 1904. No. 64364.

The Compressive Resistance of Hooped Concrete (Die Druckfestigkeit des Umschnürten Betons). Dr. R. Saliger. A mathematical examination of the strength of concrete pillars wrapped with wire, according to the method of Considère. 2000 w. Oesterr Wochenschr f d Oeff Baudienst—June 18, 1904. No. 64469 D.

Suggestions for Steel-Concrete Construction. John C. Anderson. Paper before the Louisiana Engineering Society, giving brief general discussion, with illustrations. 800 w. Jour Assn of Engng Socs—July, 1904. No. 64580 C.

See also Civil Engineering, Bridges.

Road-Making Machinery.

The Management of Road Locomotives. T. C. Aveling. Read before the Midland Munic. Officers' Assn. Points for the maintenance of road-making machinery. 2500 w. Quarry—Aug., 1904. No. 64340 A.

Steel-Pile Caisson.

A Steel-Pile Caisson at Omaha. Description, with illustration, of a cofferdam constructed with Friestedt interlocking channel bar piles. 1000 w. Eng Rec—Aug. 1, 3, 1904. No. 64396.

Timber-Concrete.

Adhesion of Timber Piles to Concrete. Translated from an article by M. E. Roussel in the *Annales des Travaux Publics de Belgiques,* giving an account, with diagrams, of experiments made on a testing machine, conforming to actual practice. 2000 w. Engr, Lond—Aug. 12, 1904. No. 64528 A.

Tunnels.

Progress on the Harlem River Tunnel of the New York Rapid Transit Railroad. Illustrated account of work on this double-track tunnel, 1,500 ft. long, part being a twin-tube cast-iron shell enclosed in concrete. 4000 w. Eng Rec—Aug. 20, 1904. No. 64500.

Some Recent Works of Railway Tunnel Improvement. Describes the relining and change of grade in the Winston tunnel, and the opening up of the Arion tunnel. Ills. 1500 w. Eng News—Aug. 4, 1904. No. 64249.

The Construction of the Simplon Tunnel (Der Bau des Simplon-Tunnels). C. J. Wagner. A detailed review of the work for the year from January 1, 1903, to January 1, 1904. 10000 w. 2 plates. Oesterr Wochenschr f d Oeff Baudienst—July 30, 1904. No. 64473 D.

Hot Springs and the Simplon Tunnel. An explanation of the conditions which have caused the interruption of this work at the Swiss side. 1800 w. Engr, Lond—Aug. 19, 1904. Serial. 1st part. No. 64664 A.

Workmen's Dwellings.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Cement.

Blast Furnace Slag and Cement in Connection with the Theory of Zulkowski (Hochofenschlacke und Zement im Lichte der Zulkowskischen Theorie). C. Canaris, Jr. An examination of the chemical properties of furnace slag and its combinations, comparing slag cement and Portland cement from the chemical standpoint. 5000 w. Stahl u Eisen—July 15, 1904. No. 64430 D.

The Constitution of Portland Cement from a Physico-Chemical Standpoint. Clifford Richardson. Address before the Association of Portland Cement Manufacturers, discussing the microscopical examination and chemical analysis of cements, showing that latter is not a sure test of their value. Tables. 7000 w. Eng Rec—Aug. 13 & 20, 1904. Also Eng News—Aug. 11, 1904. No. 64366.

Cement Works.

The Dexter Portland Cement Works. Illustrated description of mills in Pennsylvania. 2000 w. Eng Rec—Aug. 6, 1904. No. 64280.

Clays.

Clays and Their Properties. An editorial on the importance of the investigations carried on in the Division of Tests of the U. S. Dept. of Agriculture, summarizing the results, and showing the behavior of the material. 1300 w. Eng Rec—July 30, 1904. No. 64182.

Fireproofing.

Ferrell's Apparatus and Process for Fireproofing Wood. Report of the Committee on Science and the Arts on the invention of Joseph L. Ferrell. Ills. 1200 w. Jour Fr Inst—Aug., 1904. No. 64359 D.

Floor Test.

A Method of Measuring Deflections in Floor Tests. Edward Godfrey. Brief illustrated description of simple method. 350 w. Eng News—Aug. 25, 1904. No. 64613.

Paint.

Tests of Paint. Extracts from a report by Dr. Charles B. Dudley to the American Society for Testing Materials, on preservative coatings for iron and steel and methods of testing them. 2200 w. Eng Rec—Aug. 20, 1904. No. 64508.

MEASUREMENT.

Barometer.

A Portable Recording Barometer (Baromètre Altimétrique Enregistreur de Poche). An illustrated description of the Périllat recording barometer, which enables a profile of the country traversed to be made. 800 w. Génie Civil—July 16, 1904. No. 64422 D.

Mine Surveying.

Surveying and Mapping of Flat Coal Mines. Charles H. Thompson. General discussion and practical directions. 2800 w. Eng & Min Jour—Aug. 25, 1904. No. 64620.

Surveying.

Surveying at the German Municipal Exhibition at Dresden (Das Vermessungswesen auf der I. Deutschen Stadtausstellung in Dresden). Dr. Hans Löschner. With numerous illustrations showing improvements in methods of surveying, levelling, etc., with especial reference to municipal work. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—July 15, 22, 1904. No. 64413 each D.

Turnouts.

See Railway Engineering, Permanent Way.

MUNICIPAL.

Asphalt Plants.

Municipal Asphalt Plants. General description, with costs, of plants at Winnipeg and Detroit, visited by Andrew Rosewater, city engineer of Omaha, on a tour of inspection. 1000 w. Eng Rec—Aug. 20, 1904. No. 64503.

Pavements.

Specifications for Brick Pavement. Gives the principal points in the new specifications for Akron, O. The pavements are of brick. 3000 w. Munic Jour & Engr—Aug., 1904. No. 64245 C.

Paving.

Problems of Street Paving. Extracts from a report made by John W. Alvord considering various problems and proposed methods of solutions for the city of Chicago. Diagrams and tables, with discussion of materials. 5800 w. Munic Engng—Aug., 1904. No. 64263 C.

Pipe Galleries.

Pipe Galleries for New York. James C. Baylis. Discusses the effect on pavements of the frequent excavations, and of gas leakage, and the lessons to be learned from the experience of foreign cities. 2500 w. Munic Jour & Engr—Aug., 1904. No. 64244 C.

Rotterdam.

Municipal Rotterdam. Descriptions, with illustrations, of sewerage, water supply, street cleaning and other features. 1000 w. Public Works—Aug. 15, 1904. No. 64649 D.

Sewage Disposal.

Some Notes on the Cost of Cinders for Sewage Filter Beds. Ernest McCullough. Practical points on the cost and manipulation of cinders. 2200 w. Eng News—Aug. 18, 1904. No. 64369.

Small Sewage Disposal Plants. Illustrated description of four British plants. 1600 w. Engr, Lond—Aug. 5, 1904. No. 64521 A.

The Sewage Fields of Freiburg i. B. (Das Rieselfeld für die Stadtische Kanalwasser von Freiburg i. B.). Dr. P. Kresnik. An illustrated description of the sewage farms in operation since 1891. 2000 w. 1 plate. Oesterr Wochenschr f d Oeff Baudienst—June 25, 1904. No. 64470 D.

Seaside Sewage Disposal. Arthur J. Martin. Abstract of a paper before the Royal Institute of Public Health (British), giving a general review of sewage disposal of seaside towns. 1500 w. Eng News—Aug. 25, 1904. No. 64607.

Sewage Purification. C. M. Ginther. Remarks on methods of purification with a brief illustrated description of the very successful plant installed at the Eastern Indiana Hospital for the Insane. 1500 w. Sci Am Sup—Aug. 27, 1904. No. 64652.

The Glasgow Main Drainage System. A. B. McDonald. Illustrated description of a very large sewerage and sewage disposal system. 2500 w. Public Works—Aug. 15, 1904. No. 64642 D.

Standards of Purity for Sewage Effluents. Part of a paper by Prof. Dr. Dunbar (Hamburg) read before the Congress of the Sanitary Inst. at Glasgow. Discusses whether we are able to judge by the results of chemical analysis whether sewage freed from suspended matter tends to putrefy. 4500 w. Builder—Aug. 20, 1904. No. 64657 A.

Streets.

The Right to Break Up Streets. Discusses English law upon this subject. 3600 w. Engr, Lond—July 22, 1904. Serial. 1st part. No. 64229 A.

WATER SUPPLY.

Berlin.

The Supply of Berlin with Groundwater (Die Versorgung der Stadt Berlin mit Grundwasser). A review of the proposition to increase the water supply of Berlin, with an estimate of the available ground-water supply. 2500 w. Gesundheits-Ingenieur — July 31, 1904. No. 64420 B.

Birmingham.

Birmingham's New Water Supply. An illustrated detailed description of the whole undertaking. An important engineering work. 4800 w. Engr, Lond—July 22, 1904. No. 64228 A.

Copper Sulphate.

Treatment of a Reservoir of the Butte Water Co. with Copper Sulphate. Eugene Carroll. Description of favorable experience with copper sulphate for destroying vegetable organisms in water supplies; with photo-micrographs and tables. 1500 w. Eng News—Aug. 18, 1904. No. 64373.

Filtration.

An Improved Method for the Bacterial Purification of Water (Nouvelle Contribution à l'Epuration Bacterienne des

Eaux). MM. P. Miquel & H. Mouchet. Showing the excellent results obtained by filtration through a non-submerged bed of fine sand. 1000 w. Comptes Rendus—July 18, 1904. No. 64442 D.

The Philadelphia Filtration System. General description and plans of the largest filtration system in the world. 4500 w. Eng News—Aug. 18, 1904. No. 64375.

Glasgow.

The Glasgow Water-Works. Robert Wilson. Illustrated description of the Loch Katrine works, aqueducts, service reservoirs, Gorbal works, river supply works and other features. 2000 w. Public Works—Aug. 15, 1904. No. 64646 D.

Meters.

Metered Services. F. G. Kimball. Read before the Am. W.-Wks. Association. A defence of the minimum rate charged when water is sold by meter. 2500 w. Fire & Water—Aug. 27, 1904. No. 64700.

Moorland Water.

Treatment of Moorland Water to Prevent Action upon Lead Pipes. Abstract of a paper by C. C. Smith and E. M. Chaplin before the British Assoc. of Water-Works Engrs., giving account of the treatment of the water supply of Wakefield with carbonate of soda and by other methods. 1400 w. Eng Rec—Aug. 13, 1904. No. 64397.

Pumping Station.

Gainsborough Water-Works. Description of this interesting plant with illustrated details of the pumping station. 1600 w. Engr, Lond—July 29, 1904. No. 64322 A.

Some American Figures on the Operation of Pumping Stations. Items from information relating to a number of large water-works pumping plants in the United States, collected by Will J. Sands. 2200 w. Eng Rec—Aug. 6, 1904. No. 64283.

Purification.

The Purification of Water. Prof. John M. Ordway. Paper before the Louisiana Engineering Society, giving a general review. 3000 w. Jour Assn of Engng Socs—July, 1904. No. 64581 C.

Reichenberg.

The Waterworks of the City of Reichenberg (Das Wasserwerk der Stadt Reichenberg). U. Huber. A detailed account of the new works and pumping stations for the water supply of Reichenberg, Bohemia. The supply is obtained from a number of small streams. 7500 w. 6 plates. Oesterr Wochenschr f d Oeff Baudienst—June 4, 1904. No. 64465 D.

Sedimentation.

On Sedimentation. Discussion on paper by Allen Hazen on water purification. 2000 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64588 E.

Softening Water.

Notes on the Softening of Iowa Well Waters. Prof. Nicholas Knight. A condensed record of investigations in the chemical laboratory of Cornell College, Mt. Vernon, Iowa, by C. G. Eldredge. Tables. 800 w. Eng News—Aug. 18, 1904. No. 64376.

Stand-Pipe.

Damage by Ice to the Stand-Pipe at Cobourg, Ont., and the Repairs Thereto. H. C. Hodgkins. Illustrated description of bursting of sheets by water in stand-pipe freezing, and method of repairing. 700 w. Eng News—Aug. 18, 1904. No. 64367.

Submerged Pipe.

Laying a Submerged Water Pipe at North Tonawanda, N. Y. An illustrated article giving information concerning the methods adopted and difficulties encountered. 2200 w. Eng News—Aug. 4, 1904. No. 64248.

Underground Water.

The Underground Water Circulation. Charles Mortimer Cross. A study of the flow of underground water, giving examples illustrating the action, and explaining vadose circulation and deep circulation. 1200 w. Ores & Metals—Aug. 1, 1904. Serial. 1st part. No. 64259.

Wells.

Open Wells and Turbine Pumps. Dabney H. Maury. Extracts from a lecture before the American Water-Works Association, illustrating and describing wells, well strainers and well sinking at Peoria, Ill., and discussing centrifugal or turbine pumps. Also editorial. 4000 w. Eng News—Aug. 18, 1904. No. 64371.

The Additional Water Supply of Middletown, Ohio. Illustrated description of well construction, with novel arrangement of strainer pipes. 350 w. Eng News—Aug. 11, 1904. No. 64363.

WATERWAYS AND HARBORS.

Belgium.

Navigable Waterways in Belgium. E. Cecil Hertslet. Description of canals and other inland waterways, with traffic statistics, tables and maps. 6000 w. Public Works—Aug. 15, 1904. No. 64647 D.

Canals.

Canal Policy in England. W. M. Acworth. A discussion of the proposed new policy. 2000 w. Ry Age—July 29, 1904. No. 64213.

The Austrian Canal Projects (Die Trassen des Oesterreichischen Kanale). Richard Kuhn. A discussion of the proposed waterways in Austria, including the Danube-Oder canal, the Danube-Moldau canal, and the various auxiliary projects.

6000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 5, 1904. No. 64417 D.

The Pioneer Sault Canal. Charles T. Harvey. An interesting review of the history from the earliest promoting measures in 1857. 7500 w. Marine Rev—Aug. 4, 1904. No. 64265.

Canal Traction.

See Street and Electric Railways.

Dock Crane.

50-Ton Electric Crane. Description and illustration of a revolving, travelling crane, for the Southampton docks. 600 w. Engng—Aug. 12, 1904. No. 64517 A.

Dredge.

Boom Dredge and Conveyors (Drague à Bras et à Transporteurs de Deblais). H. E. Jeanin. Illustrating a special form of ladder dredge with projecting boom, designed for cutting irrigation channels in China. 1500 w. 1 plate. Mem Soc Ing Civ de France—May, 1904. No. 64445 G.

Egypt.

Irrigation Projects in Egypt and the Soudan. Extracts from a report of Sir William Garstin to Lord Cromer, describing projects for regulating the Nile, with map of White Nile region. 2500 w. Engr, Lond—Aug. 12, 1904. No. 64525 A.

Florida Coast.

The Waterway of the Florida Coast Line Canal and Transportation Co. George F. Miles. Illustrated description and map of natural waterways and connecting canals down the east coast of Florida, from Jacksonville to Key West. 2800 w. Eng News—Aug. 25, 1904. No. 64606.

Flow.

Methods of Estimating Stream Flow. John C. Hoyt. Explains the methods in use, illustrating by example. 1000 w. Eng News—Aug. 4, 1904. No. 64252.

Some Flood Discharges and Values of "n" in Kutter's Formula. R. H. Anderson. Explains method of making computations for McCall's Ferry on the Susquehanna River. 800 w. Eng News—Aug. 4, 1904. No. 64251.

Heysham Harbor.

Gas-Driven Electrical Plant at Heysham Harbor, England. Description, with illustrations, of Mond gas producer and gas-driven electric plant for lighting and supplying power for cranes, lifts, etc. 700 w. Elect Wld & Engr—Aug. 13, 1904. No. 64531.

Midland Railway Company's Steamship Service. Begins an illustrated detailed description of the construction of Heysham Harbor, with remarks on the promotion of the scheme and matters related. 2700 w. Engng—July 29, 1904. Serial. 1st part. No. 64321 A.

Hydraulic Lift.

The Hydraulic Lift Lock in the Trent Canal. John McClelland Bulkley. Illustrated description of the new lock at Peterborough, Ontario, with a lift of 65 feet, designed for 800-ton barges. Also, editorial. 4500 w. Eng Rec—Aug. 13, 1904. No. 64395.

Irrigation.

New Irrigation Projects for Egypt and the Soudan. Considers the future requirements of Egypt and the Soudan. 5400 w. Builder—Aug. 20, 1904. No. 64656 A.

Valparaiso.

The Harbor of Valparaiso (Le Port de Valparaiso). Ch. Dantin. An illustrated review, showing the present condition of the port, and the plans for its expensive improvement. 3500 w. 1 plate. Génie Civil—July 16, 1904. No. 64421 D.

MISCELLANY.

Estimates.

See Industrial Economy.

Land Drainage.

Tile Drain Laying. 2nd Prize Paper. F. N. Pitkin. Describes methods, instruments used. Ills. 5200 w. Brick—Aug., 1904. Serial. 1st part. No. 64260.

Landscape Architecture.

Landscape Architecture. Stephen Child. Lecture before the Boston Society of Civil Engineers, giving a general account of the subject, with illustrations. 2800 w. Jour Assn of Engng Socs—July, 1904. No. 64579 C.

Landslide.

A Phenomenal Landslide. Discussion on paper by D. D. Clarke on landslide involving reservoirs near Portland, Ore. 1400 w. Pro Am Soc of Civ Engrs—Aug., 1904. No. 64587 E.

St. Louis Exposition.

A Review of the Engineering Exhibits at the St. Louis Exposition. General review. 2500 w. Eng News—Aug. 11, 1904. No. 64365.

Sand Dunes.

The Problem of the Dune. F. B. Kellogg. Methods of arresting the encroachments of sand, by growing beach grass and otherwise. 2000 w. Cal Jour of Tech—May, 1904. No. 64640 C.

Shovel.

The Increasing Capacity of Power Shovels. George E. Walsh. Remarks on the great increase in capacity during the last year or two, and the effect on mining, excavating of canals, and general excavation work. 1400 w. Ir Trd Rev—Aug. 4, 1904. No. 64255.

ELECTRICAL ENGINEERING

COMMUNICATION.

Alaskan Cable.

Completion of the Alaskan Cable. Article reprinted from *Telegraph Age*, giving an account of the laying of a cable from Skagway to Seattle, and telling of other telegraph and wireless projects in Alaska. 1500 w. Elec Rev, N. Y.—Aug. 13, 1904. No. 64538.

Automatic Telephone.

The Strowger Automatic Telephone System (Het Automatisch Telephonsystem van Strowger). N. Heinzelmann. A fully illustrated description of the instruments and switchboard, and an account of the operation of the system in the United States. 6000 w. 1 plate. De Ingenieur—June 25, 1904. No. 64477 D.

Exchange.

Multiple Switchboard Exchange at Neustadt a. d. Haardt (Vielfach-Umschalteeinrichtung in Neustadt a. d. Haardt). J. Jacob. A very complete description of a modern exchange with lamp signals, central battery, etc. Two articles. 8000 w. Elektrotech Zeitschr—July 14, 21, 1904. No. 64447 each B.

Fault Location.

See Electrical Engineering, Measurement.

Glasgow Telephones.

The Glasgow Municipal Telephones. A. R. Bennett. Illustrated description of the principal features of a system with over 8,000 working lines. 2500 w. Public Works—Aug. 15, 1904. No. 64644 D.

Glasgow Municipal Telephone System: Estimates and Results Compared. Herbert Laws Webb. Showing that the original estimates of cost and size of plant have been greatly exceeded. Curves. 1600 w. Elec Rev, Lond—Aug. 5, 1904. No. 64551 A.

Janus Telephone.

The Janus Telephone System. Dr. Alfred Gradenwitz. Illustrates and describes this system which enables each telephone of a private network to be used simultaneously with those belonging to the system of the telephone company. 600 w. Sci Am Sup—Aug. 27, 1904. No. 64655.

Railway Telephones.

See Railway Engineering, Conducting Transportation.

Ship Telegraph.

See Marine and Naval Engineering.

Space Telegraphy.

A Novel Wave Meter for Wireless Telegraphy. An illustrated description of the "multiplier rod" designed by Prof. Slaby, explaining the principle underlying the apparatus. 1200 w. Sci Am—Aug. 6, 1904. No. 64254.

Synthetic Wireless Telegraphy. A. Frederick Collins. Describes a synthetic transmitter and receiver which the writer considers would combine all the essential improvements of all workers in this field. 2800 w. Elec Wld & Engr—July 30, 1904. No. 64237.

The Application of Space Telegraphy to Moving Trains (Ueber die Anwendung der Drahtlosen Telegraphie in Fahrenden Zugen). Wilhelm Biscan. Describing successful experiments in communicating with moving trains on the Aussig-Teplitz railway. 2500 w. 2 plates. Oesterr Wochenschr f d Oeff Baudienst—June 18, 1904. No. 64466 D.

The Government Wireless Report. Abstract of U. S. Navy Dep't report, recommending that the navy have control of all the wireless systems along the coasts of the United States and its outlying possessions. 700 w. Elec Wld & Engr—Aug. 20, 1904. No. 64533.

Telephone Cable.

Economical Features of the Austin Telephone Company's All-Cable Plant, Austin, Minn. Illustrated description of an aerial telephone cable plant, and other features of the equipment of the Austin exchange. Also editorial. 1800 w. Elec Wld & Engr—Aug. 20, 1904. No. 64536.

Telephone Service.

The Relation of Telephone Traffic to Efficient Service. Howard S. Knowlton. Discussion of details of telephone service, with traffic curves. 4000 w. Elec Wld & Engr—Aug. 13, 1904. No. 64530.

Telephony.

The Evolution of Telephonic Protective Apparatus. Charles H. Coar. Discusses the various devices to protect telephone lines not only from lightning, but against other destructive currents. States the qualifications demanded by some of the larger companies. 2500 w. Elec Wld & Engr—July 30, 1904. No. 64236.

Wireless Telephony by Use of the Properties of Selenium (Draadlooze Telefonie en de Eigenschappen en Toepassingen van Selenium). A. H. Opten Noort. Discussing the experiments of Simon, Duddell, Ruhmer and others in the transmission of speech without wires. Two articles. 7500 w. De Ingenieur—June 18, 25, 1904. No. 64476 each D.

DISTRIBUTION.

Cables.

The Computation and Determination of Self-induction and Current Charge of Single and Polyphase Cables (Zur Berechnung und Experimentellen Bestimmung der Selbstinduktion und Stromrückleitung von Einphasen und Drehstromkabeln). Leo Lichtenstein. Substituting an ideal conductor in place of the actual one, for purposes of calculation. Two articles. 6000 w. Zeitschr f Elektrotechnik —July 31, Aug. 7, 1904. No. 64459 each D.

Conductors.

The Computation of Simple Conductor Systems (Ueber die Berechnung von Leitungen ohne Knotenpunkte). Ernst Kronstein. Developing formulas for simple conductors, or feeder lines. 2500 w. Zeitschr f Elektrotechnik—July 17, 1904. No. 64457 D.

"Earths."

The Localization of "Earths" on Feeders and Networks. Horace Boot. Describes the method which the writer has found the best, giving some results. 1000 w. Elec Rev, Lond—July 22, 1904. No. 64225 A.

Four-Wire.

Some Experiences in the Regulation of a Three-Phase, Four-Wire, Mixed Distribution. C. W. Hutton. Paper before the Pacific Coast Electric Transmission Assoc., giving an account of troubles and remedies with a 200-volt electric distribution system in Sacramento, Cal. Voltage curves. 1000 w. Jour of Elec—Aug., 1904. No. 64561 C.

House Fittings.

Switches and Fuses for House Use (Hausanschlusssicherungen with Feuersicheren Patronen). W. Klement. Illustrating a variety of fittings as made by the Siemens-Schuckert Works for house wiring. 6000 w. Elektrotech Zeitschr—July 14, 1904. No. 64446 B.

Line Construction.

New System of Wire Fixing and Protecting Apparatus for Overhead Electric Light and Power Wires and Cables. Illustrates and describes the system of M. N. K. Astafieff and the devices he adopts for holding the wires, coupling them together, and giving the necessary fuse protection. 1700 w. Elec Wld & Engr—Aug. 6, 1904. No. 64333.

Mains.

A Method of Laying Bare Underground Mains. Illustrated description of the "simplified" solid system. The insulating compound is composed of refined carbolite. 2200 w. Elect'n, Lond—Aug. 19, 1904. No. 64674 A.

Switches.

Long-Distance Switches (Ueber Fernschalter). Fr. Lindenstruth & O. Forster. Illustrating details of switches to be operated electrically at a distance, employing a variety of contact breakers. 2500 w. Elektrotech Zeitschr—July 28, 1904. No. 64451 B.

Long-Distance Switches. F. Lindenstruth and O. Forster. Translation of an article in *Elektrotechnische Zeitschrift*. Considers the construction of certain long-distance switches which can be operated by hand or automatically. Ills. 1500 w. Elec Engr, Lond—Aug. 19, 1904. Serial. 1st part. No. 64669 A.

Transformers.

Notes on Transformer Design (Ueber den Entwurf von Transformatoren). Arthur Müller. Deriving formulas for the most efficient proportion of iron cores and coils. 2000 w. Zeitschr f Elektrotechnik —July 17, 1904. No. 64456 D.

ELECTRO-CHEMISTRY.

Batteries.

Storage Batteries. A discussion of the treatment they should receive, giving notes based on long experience. 2800 w. Elec Rev—July 22, 1904. No. 64226 A.

The Historical Development of the Secondary Element (Die Geschichtliche Entwicklung der Sekundär-Elemente). Otto Hildebrand. A review of the various forms of electric storage devices, from the observations of Gautherot, in 1802, down to the present time. 2500 w. Elektrochem Zeitschr—August, 1904. No. 64452 G.

The Storage Battery. J. Lester Woodbridge. A lecture delivered at Stevens Inst. of Tech. Deals with the history, present practice in battery construction, capacity, operation, troubles, applications, &c. 4300 w. Stevens Ind—July, 1904. No. 64344 D.

Cantor Lectures.

Recent Advances in Electro-Chemistry. Bertram Blount. The Cantor lectures in London, giving a general review of copper refining and many other branches of electrochemistry. Diagrams. Serial. Part I. 7000 w. Jour Soc of Arts—Aug. 12, 1904. No. 64570 A.

Diaphragm.

A New Form of Diaphragm for Electrolytic Cells. F. Mollwo Perkin. Description, with illustration, of a diaphragm consisting of two cylinders of glazed ware, with five perforations, and asbestos, or other substance, filling the space between them. 700 w. Elec-Chem & Met—July, 1904. No. 64377 C.

Dissociation.

The Development of the Theory of Electrolytic Dissociation. Prof. Svante

Arrhenius. Address before the Royal Institution of Great Britain, with diagrams. 4000 w. Pop Sci Monthly—Sep., 1904. No. 64578 D.

Electro-Metallurgy.

Application of the Electric Furnace to the Metallurgy of Iron and Steel. P. McN. Bennie. Abstract of a recent paper, giving a classification of electric iron and steel processes and descriptive notes. 3000 w. Elec-Chem Ind—Aug., 1904. No. 64330 C.

Solubility of Gold in Certain Oxidizing Agents. V. Lenher. An account of an experimental investigation of the solubility of gold under the influence of nascent oxygen. 1800 w. Elec-Chem Ind—Aug., 1904. No. 64331 C.

See also Electrical Engineering, Transmission.

Ozone.

The Production and Utilization of Ozone. John B. C. Kershaw. Describes and illustrates ozonizers of recent date, and the experimental work carried out in connection with the production and utilization of ozonized air. 1500 w. Elec Rev, Lond—Aug. 19, 1904. Serial. 1st part. No. 64672 A.

ELECTRO-PHYSICS.

Alternating Currents.

A Physical Conception of Some Alternating-Current Phenomena. Lamar Lyndon. Discussion, with diagrams and curves, showing effects of inductance, resistance, etc. Serial. Part I. 2000 w. Elec Wld & Engr—Aug. 27, 1904. No. 64725.

Earth Currents.

Electric Tides and Earth Currents. W. H. Sharp. Gives results of researches made with a view to determining the origin and laws of earth currents. 1500 w. Elec Rev, Lond—Aug. 19, 1904. Serial. 1st part. No. 64671 A.

The Earth Currents. Abstract of a lecture by E. Guarini before the Societé Belge d'Astronomie. 400 w. Elec Rev, N Y —Aug. 20, 1904. No. 64542.

Electrostatics.

Electrical Transmission Electrostatically Treated. J. Stanley Richmond. Aims to show that the science of electricity is really one of electrostatics, or of the rotative pressures of the electrical conditions of bodies of matter. 1500 w. Elec Rev, N Y —Aug. 6, 1904. No. 64273.

Rigidance.

Rigidance, a New Name for the Reciprocal of Capacity. James E. Ives. Discussion of mechanical analogies of electrostatic capacity, with formulæ and diagrams. Also editorial. 800 w. Elec Wld & Engr—Aug. 13, 1904. No. 64529.

Theory.

Reflections Suggested by the New Theory of Matter. Presidential address by the Right. Hon. A. J. Balfour to the British Assn. A lucid survey of the electrical theory of matter. 6000 w. Elect'n, Lond —Aug. 19, 1904. No. 64675 A.

GENERATING STATIONS.

Alternators.

Pressure Drop in Alternators. William Cramp. Discussion of the theory of alternator design, with diagrams. 3500 w. Elec Engr—Aug. 12, 1904. No. 64557 A.

Armature Reaction.

Armature Reaction in Alternators. James B. Henderson and John S. Nicholson. Account of a research to compare the theoretical and experimental armature reaction of a 30-kilowatt, three-phase alternator at the University of Glasgow. Diagrams. 2500 w. Elect'n, Lond—Aug. 5, 1904. No. 64545 A.

Brimsdown.

Power Supply to Tramways in North London. Illustrated description of station of the North Metropolitan Electrical Power Supply Co., furnishing current at 11,000 volts. Serial. Part I. 2000 w. Elect'n, Lond—Aug. 12, 1904. No. 64546 A.

Brussels.

The New Brussels Electric Power Station at Anderlecht. Frank C. Perkins. Illustrated description of a railway power station and its equipment. 1200 w. Engr, U S A—Aug. 15, 1904. No. 64676 C.

Commutation.

A Practical Test on Commutation. Arthur Keller. Discussion of commutation phenomena, and account of tests made by measuring the voltage drop between the brush and different commutator bars under it, with diagrams. Also editorial. 1500 w. Elec Wld & Engr—Aug. 20, 1904. No. 64534.

Dynamos.

High-Speed Direct-Current Dynamos for Railway Service (Schnellaufende Gleichstrom-Generatoren für Bahnbetrieb). H. Kikli-Kehlstadt. Illustrating a very substantial continuous-current machine designed by Rieter for direct-connection to hydraulic turbines making 500 revolutions per minute. 2000 w. Schweiz Bauzeitung —July 16, 1904. No. 64427 B.

Economics.

Economics in Supply Stations. A. J. Arnot. Read before the Elec. Assn. of Sydney. Discusses points of importance in the economical equipment and control of stations. 7500 w. Aust Min Stand—June 23 and 30, 1904. Serial. 2 parts. No. 64336 each B.

High School.

The Electric Plant of the Technical High School at Darmstadt (Die Elektrischen Einrichtungen im Neuen Kraftwerk der Technischen Hochschule Darmstadt). Prof. A. Sengel. An illustrated description of the isolated plant furnishing current for light, power and educational purposes at the Darmstadt Polytechnic. 3000 w. Zeitschr d Ver Deutscher Ing—July 16, 1904. No. 64400 D.

Hotel Plant.

See Mechanical Engineering, Power and Transmission.

Hydro-Electric.

The Hydro-Electric Station at Adelboden (Usine Hydro-Electrique d'Adelboden, Berne). P. Pflug. Describing a small Swiss station, using a Pelton wheel under 280 metres head, direct-connected to two Brown, Boveri dynamos. Two articles. 3000 w. Bull Tech de la Suisse Rom—June 25, July 10, 1904. No. 64478 each D.

Ipswich.

Ipswich Electric Lighting and Tramways Undertaking. Illustrated description of an English electric station and its equipment. 2000 w. Elec Rev, Lond—Aug. 5, 1904. No. 64550 A.

Leek.

Leek Electricity Works. Illustrated description of small English electric station, driven by town gas. 1600 w. Elec Rev, Lond—Aug. 12, 1904. No. 64553 A.

Loads.

Artificial Loads for the Dissipation of Electric Power. F. H. Davies. On the arrangement of a properly designed and permanent water load, considering points of importance. Ills. 2500 w. Elec Engr, Lond—July 22, 1904. No 64223 A.

London.

The London Underground Electric Railways Power Station. Illustrations and description of partially completed Chelsea station, in which will be installed ten 5500-kilowatt Westinghouse steam-turbine generators. 400 w. Tram & Ry Wld—Aug. 11, 1904. No. 64576 B.

Mining Plant.

See Mining and Metallurgy, Mining.

Railway Shops.

See Railway Engineering, Permanent Way.

St. Louis Fair.

The Largest Generating Unit at the World's Fair. Illustrated description of a 5000-horse-power Allis-Chalmers engine and Bullock three-phase generator, in operation in Machinery Hall. 2000 w. Elec Wld & Engr—Aug. 13, 1904. No. 64532.

Sheffield, Eng.

Two-Phase Turbo-Generator Station at Sheffield, England. Brief illustrated description of the change from the single to the two-phase system. 900 w. Elec Wld & Engr—July 30, 1904. No. 64233.

Stator Deflection.

Deflection of Stator of Direct-Current and Three-Phase Generators. F. Niethammer. Mathematical discussion of the mechanical deflection of dynamo yokes and frames, with diagram. 500 w. Elec Wld & Engr—Aug. 27, 1904. No. 64726.

Storage Battery.

A Unique Storage-Battery Installation. Henry Flay. Illustrated description of a large auxiliary and regulating storage-battery and booster plant at the lead mines of the St. Louis Smelting & Refining Co., St. Francois, Mo. 1500 w. Elec Wld & Engr—Aug. 20, 1904. No. 64535.

New Storage Battery Plant of the Northwestern Elevated Railroad, Chicago. Illustrated description of substation and method of operating battery. 1500 w. St. Ry Jour—Aug. 13, 1904. No. 64565 C.

The Proper Care of Storage Batteries (Soins à Donner aux Batteries d'Accumulateurs). E. Dieudonné. A discussion of the influence which proper care has upon the life and performance of electric storage batteries. Serial. Part I. 2500 w. Revue Technique—July 25, 1904. No. 64426 D.

See also Electrical Engineering, Electro Chemistry.

Tasmania.

Electric Lighting of Devonport, Tasmania. Illustrated description of a small electric station. 1200 w. Elec Engr—Aug 5, 1904. No. 64555 A.

Vouvry.

The Vouvry (Switzerland) Electric Power Plant. Illustrated description of a plant on the Rhone, driven by water supplied by the Tanay Lake. Single-phase current. 3000 w. Trac & Trans—Aug., 1904. No. 64348 E.

Wind Driving.

Wind-Driven Electrical Works. Dr. Alfred Gradenwitz. Brief illustrated description of a central station near Askov, Denmark, which has been worked with wind power for a year with satisfactory results. 900 w. Can Engr—Aug, 1904. No. 64339.

"Zone" Dynamos.

"Zone" Dynamos and Motors. Henry F. Joel. Illustrated description of dynamos and motors having a single field coil directly over the neutral zone of the armature. Serial. 2 parts. 1600 w. Elec Rev, Lond—Aug. 5 and 12, 1904. No. 64549 each A.

LIGHTING.

Incandescent Lamps.

The Conditions of Maximum Economy of Incandescent Lamps (Détermination des Conditions d'Economie Maxima pour le Fonctionnement des Lampes Electriques à Incandescence). Aymard Valéry. Deriving formulas including the first cost, life, and consumption of electric energy, for the determination of maximum economy. 1500 w. Revue Technique—July 25, 1904. No. 64425 D.

Lighting Plant.

Lighting Plant of a Large Office Building. Illustrated description of the generating equipment of the Whitehall Building, New York. 1400 w. Am Elect'n—Aug., 1904. No. 64173.

Nernst.

Improved Forms of the Nernst Lamp (Neue Ausführungsformen der Nernst lampe). Dr. Salomon. Illustrating a variety of mountings as well as the so-called "express" lamp, combining the Nernst and incandescent systems. 2000 w. Elektrotech Zeitschr—July 21, 1904. No. 64449 B.

See also Generating Stations.

MEASUREMENT.

Conductivity.

The Rapid Measurement of the Conductivity of Copper Electrolytes. Lawrence Addicks. An illustrated description of a method for quickly determining the conductivity of a solution which should be especially useful in electrolytic refining works. 1000 w. Elec-Chem Ind—Aug., 1904. No. 64329 C.

Fault Location.

Two Methods of Locating Faults in Telephone Cables. H. B. Stabler. Description with diagrams of methods used where paper insulation of lead-sheathed cables gets wet. 2000 w. Elec. Wld & Engr—Aug. 27, 1904. No. 64724.

Meters.

The Organization and Management of a Central Station Meter Department. A. J. Cridge. Outlines some of the methods adopted in the equipment, maintenance and working of a meter department in connection with an electricity supply undertaking. 3800 w. Elec Rev, Lond—July 29, 1904. No. 64312 A.

Motor Testing.

Method for Measuring the Output of Induction Motors. E. Alexanderson. Explains an interesting method of testing induction motors. It is essentially a method for determining torque and applies to power only when the speed is taken into account. 1300 w. Elec Wld & Engr—Aug. 6, 1904. No. 64335.

Reichsanstalt.

See Mechanical Engineering, Measurement.

Slip Meter.

A New Strobscopic Slip Meter (Ein Neuer Stroboskopischer Schlüpfungsmesser). Dr. G. Wagner. A description of the operation of apparatus using the principle of persistence of vision upon intermittent flashes of light for determining the slip of non-synchronous alternating and polyphase motors. 6000 w. Glasers Annalen—July 15, 1904. No. 64410 D.

Testing.

Notes on Testing. M. A. Sammett. Calls attention to the importance of temperature rise of apparatus under load in testing machines, and describes method giving accurate results. 1800 w. Elec Rev, N Y—Aug. 27, 1904. No. 64707.

Units.

Electrotechnical Systems of Units. Prof. David Robertson. A review of a paper by Fritz Emde before the Electrotechnischer Verein, on fundamental and derived units, with diagram. 1200 w. Elect'n, Lond—Aug. 12, 1904. No. 64548 A.

Wattmeters.

Calibration of Recording Wattmeters. George T. Hanchett. Considers methods used in testing meters, and gives information and suggestions. 2200 w. Am Elect'n—Aug., 1904. No. 64178.

MOTORS.

Direct-Current Motors.

Synopsis of Fundamentals Pertaining to Speed Variations in Direct-Current Motors and Details of a Motor Having a Wide Speed Range. Albert F. Hemingway. Relates briefly to the character and limitations, with illustrated description of a type of motor with wide range of speed variation. 2500 w. Am Elect'n—Aug., 1904. No. 64174.

Motor Efficiency.

The Calculation of Motor Efficiency in Railway Service (Die Berechnung der Motorleistung im Bahnbetriebe). Maximilian Müller. With graphical diagrams showing relations of load, speed, stops, etc., in determining the efficiency of railway motors. 3000 w. Zeitschr f Elektrotechnik—July 24, 1904. No. 64458 D.

Motor Testing.

See Electrical Engineering, Measurement.

Multiple Control.

Multiple Control of Press Motors in San Francisco. Wyatt H. Allen. Illustrated description of the system of electric driving of the Mutual Label & Lithograph Co., where a variety of motors are used, with different requirements for speed variation. Illustrations and curves. 2400 w. Elec Wld & Engr—Aug. 27, 1904. No. 64723.

Single Phase.

On Single-Phase Commutating Motors. K. Michelmayer. Abstract translation from the *Elektrotechnische Zeitschrift*. A review of various types of motors, comparing them with the continuous-current motor. 4300 w. Elec Engr, Lond—July 29, 1904. No. 64310 A.

Single-Phase Series Motor. Ralph McNeill. Describes a construction free from interruption of current in any single armature circuit. 800 w. Elec Wld & Engr—Ang. 6, 1904. No. 64334.

Single-Phase Power Motors. R. B. Elder. Paper before the Pacific Coast Electric Transmission Assoc., discussing the single-phase alternating current motor principally from the commercial standpoint. 3000 w. Jour of Elec—Aug., 1904. No. 64559 C.

See also Street and Electric Railways.

TRANSMISSION.

Direct-Current.

The 70,000-Volt Continuous Current Transmission Experiments at Sécheron. A. Steens. Describes tests and claims superiority of direct over alternating-current. 2800 w. Eng Rec—Aug. 6, 1904. No. 64285.

Electrochemical Works.

Power Transmission for Electrochemical Works. Louis Bell. An analysis of the cost of developing water-powers for electrochemical plants. 2000 w. Elec-Chem Ind—Aug., 1904. No. 64327 C.

High-Voltage.

A Sixteen-Mile, 80,000-Volt Experimental Line. A. C. Balch. A paper before the Pacific Coast Electric Transmission Assoc., giving an illustrated account of experience in Southern California, particularly with insulators. 2500 w. Jour of Elec—Aug, 1904. No. 64558 C.

Mexico.

The Guanajuato, Mexico, Power Transmission. Robert McF. Doble. Illustrated detailed description of a fine power transmission plant. 3500 w. Elec Wld & Engr —Aug. 6, 1904. No. 64332.

Line Construction.

Medium-Span Line Construction. C. A. Copeland. Paper before the Pacific Coast Electric Transmission Association, giving an illustrated description of electric transmission lines in Southern California, with 225-ft. spans and wooden poles, and 300-ft. spans and steel poles. 2200 w. Eng News —Aug. 18, 1904. No. 64374.

Switching.

New Switching Station at Colorado City. Ilustrated detailed description. 1500 w. Elec Rev, N Y—July 30, 1904. No. 64168.

MISCELLANY.

Accidents.

Accidents from Electrical Machinery. Abstract from a report of the British Electrical Inspector of Factories, G. Scott Ram, on electric shock and mechanical accidents. 2400 w. Mech Engr—Aug. 13, 1904. No. 64681 A.

Bristol Fire.

Some Notes on the Bristol Electricity Works Fire. H. Faraday Proctor. Read before the Incor. Munic-Elec. Assn. A statement of the facts in regard to the fire which occurred Dec. 23, 1903, and the damage and the cause. Discussion. 4800 w. Elect'n, Lond—July 29, 1904. No. 64315 A.

Convention.

In Eighth Annual Convention Assembled. A complete unofficial report of the discussions held upon the papers read before the Monterey convention of the Pacific Coast Electric Transmission Assoc. 40,000 w. Jour of Elec—Aug., 1904. No. 64562 C.

Electrical Terms.

Voltage, Potential and Direction of Transmission. J. Stanley Richmond. Gives the writer's conception of these terms. 500 w. Elec Wld & Engr—July 30, 1904. No. 64234.

General Electric Co.

The Works of the General Electric Company. A general review of the Schenectady works, with plan and illustrations of tools, Curtis steam turbine, etc. Serial. 2 parts. 600 w. Engng—Aug. 5 and 12, 1904. No. 64511 each A.

Laboratory Appliances.

See Mining and Metallurgy, Gold and Silver.

Telpher Line.

See Street and Electric Railways.

South Africa.

Electric Engineering in South Africa. John Roberts. Principally an account of the municipal undertaking in Durban, Natal. 4500 w. Elect'n, Lond—July 29, 1904. No. 64314 A.

Standardisation.

The Standardisation of Electrical Machinery. An interim report of the British Engineering Standards Committee on generators, motors and transformers. 1500 w. Elect'n, Lond—Aug. 12, 1904. Also Engng—Aug. 12, 1904. No. 64518 A.

INDUSTRIAL ECONOMY

Contractors.

The Legal Obligations of a Contractor. Considers the rights and liabilities of those who enter upon the duty of carrying out large undertakings in England. 2000 w. Engr, Lond—Aug. 19, 1904. Serial. 1st part. No. 64662 A.

Cost-Keeping.

The Methodical Distribution of Shop Costs. H. H. Kress. Description of a cost-keeping system in operation in a large manufacturing plant, with many forms used. Serial. 1st part. 2500 w. Ir Age —Aug. 18, 1904. No. 64603.

Education.

Technical High Schools or Technical Universities (Technische Hochschulen oder Technische Fakultäten). O. Kammerer. A comparison between methods of technical education in Germany and America and the relation of the German technical high school to the university system. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 6, 1904. No. 64407 D.

Industrial Education in Germany. U. S. Deputy Consul Meyer. Abstract from Consular Reports, giving a general review of German industrial schools. Serial. 2 parts. 6000 w. Am Mach—Vol. 27. Nos. 33 and 34. No. 64598 C.

Estimates.

Engineers' Estimates of Cost. S. Whinery. Argument that the engineers' estimate should include only the engineering features of the work, and that he should not assume responsibility for other contingencies. Also editorial. 5000 w. Eng News—Aug. 11, 1904. No. 64362.

The Causes of Underestimates of Cost of Public Works. Editorial on engineers' estimating in general, with some reference to S. Whinery's article on Aug. 11. Eng News—Aug. 25, 1904. No. 64614.

Invention.

Address to the Engineering Section of the British Association. Hon. Charles A. Parsons. Remarks on the subject of invention and patents, including discoveries in physics, mechanics, chemistry and geology. 6000 w. Engng—Aug. 19, 1904. No. 64668 A.

Laboratory.

The Van't Hoff Laboratory at the University of Utrecht (Das Van't Hoff Laboratorium der Reichsuniversität zu Utrecht). Ernst Cohen. A general description, with plans, of the new chemical and physical laboratory, with an account of the opening ceremonies. 3500 w. Zeitschr f Elektrochemie—July 15, 1904. No. 64453 F.

Manual Training.

The Industrial Value of Manual Training. Frank T. Carlton. A discussion of the opportunities awaiting the pupil of the manual training school in the industrial operations of the United States. 2000 w. Engineering Magazine—September, 1904. No. 64482 B.

Tariff Commission.

Report of Mr. Chamberlain's Tariff Commission. A review of the first report of the Commission appointed to inquire into the probable effect of fiscal changes on the trade of the country. The present report deals with the heavy iron and steel trades. Also editorial. 7000 w. Ir & Coal Trds Rev—July 22, 1904. No. 64232 A.

Workmen's Dwellings.

The Structural Aspect of the Housing Problem. A. B. McDonald. Plans and descriptions of houses for the working classes in Glasgow. 1100 w. Public Works—Aug. 15, 1904. No. 64643 D.

MARINE AND NAVAL ENGINEERING

Anti-fouling Compounds.

Anti-fouling Compositions. From *Farben Zeitung*. Gives opinions from various authorities on submarine paints, and gives some new compositions. 2500 w. Sci Am Sup—Aug. 27, 1904. No. 64654.

Barges.

Barges Nos. 94 and 95, for the Standard Oil Company. Brief illustrated description of two of the largest bulk oil-carrying vessels ever built in the United States. 1100 w. Marine Engng—Aug, 1904. No. 64170 C.

Battleship.

The Great Battleship Ohio. Illustration and brief description and history of other

U. S. naval vessels bearing same name. 1200 w. Marine Rev—Aug. 18, 1904. No. 64712.

Boilers.

Report of the Committee on Naval Boilers. Full text of report of British Admiralty committee on water-tube boilers, with editorial comment. 7000 w. Engng—Aug. 5, 1904. No. 64515 A.

The Mumford Water-Tube Boiler. Illustrated description of a water-tube boiler designed to meet the requirements of torpedo-boats, launches, and similar vessels. 1000 w. Engng—Aug. 19, 1904. No. 64-667 A.

Bulkhead Doors.

Pneumatic Hydraulic Device for Closing Bulkhead Doors (Pneumatisch-hydraulische Schottenschliessvorrichtung). Hermann Hildebrandt. Illustrating the system used on the steamers of the North German Lloyd lines for controlling the bulkhead doors from the bridge. 2000 w. Zeitschr d Ver Deutscher Ing—July 16, 1904. No. 64402 D.

Caronia.

The New Cunard Liner Caronia. Description of steamship recently launched on the Clyde, with gross tonnage of 21,000 and to have 21,000 horse power. Illustration and diagram showing comparative sizes of Cunard liners. 1500 w. Prac Engr—Aug. 12, 1904. No. 64678 A.

Draft.

The Draft of Vessels in Motion in Shallow Channels Compared with Their Stationary Draft. Henry N. Babcock. A record of observations upon the actual draft of large steamships when under way, as compared with their draft at their piers, with inferences. 2500 w. Eng News—Aug. 4, 1904. No. 64250.

Dry-Dock Plant.

See Mechanical Engineering, Internal-Combustion Motors.

Full-Rigged Ships.

The American Full-Rigged Ship. An illustrated article giving facts of interest in regard to a type of vessel rapidly disappearing. 2000 w. Naut Gaz—Aug. 4, 1904. No. 64266.

Japanese Navy.

The Japanese Navy. Rear-Admiral Sa-Sow. Paper read before Japanese Institution of Naval Architects, translated by Prof. Terano. A full description of warships built for Japan since 1897, with diagrams, tables and curves of bending moments, etc. 1500 w. Engng—Aug. 12, 1904. No. 64519 A.

Motor-Boat Race.

The British International Cup. Illustrated description of race in the Solent, near Isle of Wight, and of the motor boats which took part in it. 2200 w. Auto Jour—Aug. 6, 1904. No. 64716 A.

Calais-Dover Motor-Boat Race. Illustrated description of race and of boats which took part. 2000 w. Auto Jour—Aug. 13, 1904. No. 64717 A.

Motor Boat Reliability Trials. Illustrated descriptions of the entered boats. 3000 w. Auto Jour—July 30, 1904. No. 64291 A.

Motor Boating. Results of the Reliability Trials. Judges report and description of motor boat trials held in Southampton Water, England, with illustrations. 2000 w. Auto Jour—Aug. 13, 1904. No. 64718 A.

"Ontario."

Handsome New Coasting Steamship. Description, with illustration, of the "Ontario," built by the New York Shipbuilding Co. for the Merchants and Miners' Line, and brief history of this line. 1500 w. Naut Gaz—Aug. 11, 1904. No. 64699.

Schooners.

Development of the Schooner in American Waters. John H. Morrison. Reviews the history of this type of merchant vessel. Ills. 4000 w. Naut Gaz—Aug. 4, 1904. No. 64267.

Ship Telegraph.

Naval Telegraph Instruments. Reviews various means of communication, principally electrical, between the bridge, engine room and other parts of a ship. 1500 w. Elec Rev, Lond—Aug. 19, 1904. No. 64673 A.

Steamboat Test.

Boiler and Engine Test of a Small Steamboat. Warren Johnson. Paper before the Louisiana Engineering Society, giving data and results of short test of propeller boat having 17-horse-power engines, on the Mississippi. 800 w. Jour Assn of Engng Socs—July, 1904. No. 64582 C.

Steamships.

Twin-Screw Steamship Baltic, of the White Star Line, the Largest Ship Afloat. An illustrated detailed description of this large vessel and its equipment. 2800 w. Marine Engng—Aug., 1904. No. 64169 C.

Steamship Design.

Steamship Design. Carl C. Thomas. General account of the operations involved in designing vessels and their machinery, with cross section and construction data of a steamship. 3500 w. Cal Jour of Tech—May, 1904. No. 64636 C.

Torpedo Boat.

Torpedo Boat "No. 293" for the French

Navy. Illustrated description of boat fitted with Parsons steam turbines, 130 ft. long and of 26½ knots speed. 1000 w. Engng—Aug. 5, 1904. No. 64514 A.

Tug.

Ocean-Going Steam Tug Conestoga. Illustrated description of a new tug for the Philadelphia and Reading Railroad Company. 400 w. Marine Engng—Aug., 1904. No. 64172 C.

New Steel Tug Cornell. Description and illustration of a Hudson River towing steamer built by the Townsend-Downey Shipbuilding Co. 700 w. Naut Gaz—Aug. 18, 1904. No. 64711.

MECHANICAL ENGINEERING

AUTOMOBILES.

Carburetters.

See Mechanical Engineering, Internal-Combustion Motors.

Control.

A New Method of Control. Illustrated description of the Hopkins device for the regulation of the time of the exhaust valve of internal-combustion motors. 700 w. Autocar—Aug. 6, 1904. No. 64714 A.

Daimler.

The 28 H. P. Daimler Car. An illustrated detailed description. 1200 w. Autocar—July 30, 1904. Serial. 1st part. No. 64306 A.

Fire Engines.

Automobile Steam Fire Engines. M. Reichel. Illustrated description of steam-motor fire engines in Hanover, Germany, and their successful operation. 2000 w. Engr, Lond—Aug. 12, 1904. No. 64527 A.

Fuel.

Coal Tar and Spirits as Motor Fuels. Account of experiments made on the road with a Napier-Parsons parcels-delivery car, and comparison of coal-tar spirits with benzol for internal-combustion motors. 1000 w. Autocar—Aug. 6, 1904. No. 64713 A.

Gears.

Design for a Change Speed Gear for Motor-Driven Vehicles. J. E. Pfeffer. Working drawings and description of a design used on various types of touring cars, varying from 20 to 30 horse-power. 2400 w. Am Elect'n—Aug., 1904. No. 64177.

The Wilson and Pilcher Change-Speed Gear. Description and drawing of the latest design and practice. 1600 w. Autocar—July 23, 1904. No. 64220 A.

Krieger.

A Gasoline Electric Automobile. Emile Guarini. Illustrated detailed description of the Krieger 20 h.-p. gasoline-electric automobile, with particulars. 1400 w. Sci Am Sup—Aug. 27, 1904.—No. 64653.

Moderate Speed.

The Rational Car. Illustrates and describes a car of moderate speed, combined with simplicity and reliability. 900 w. Autocar—July 23, 1904. No. 64219 A.

Motor Van.

The Napier-Parsons Light Motor Van. Illustrates and describes a light delivery van of simple construction. 3300 w. Auto Jour—July 23, 1904. No. 64218 A.

Mountain Climbing.

Automobiles Climb Mount Washington. Angus Sinclair. An illustrated account of the feat undertaken July 11, 1904. Also some information in regard to the Mt. Washington railway. 1300 w. Loc Engng—Aug., 1904. No. 64210 C.

Petrol Car.

A 3-Cylinder "National" Petrol Car. Illustrated detailed description. 1500 w. Auto Jour—July 23, 1904. No. 64217 A.

Ravel Motor.

The Ravel "Intensive" Motor. Illustrated description of a new motor where an endeavor has been made to obtain a higher power within a definite bulk and weight. 1000 w. Motor Car Jour—Aug. 6, 1904. No. 64701 A.

Scotland.

Motor Vehicles in Scotland. More especially discussing the trade and manufacture of motor vehicles. 2200 w. U S Cons Repts—June, 1904. No. 64295 D.

Tires and Springs.

Tyres and Springs. J. S. V. Bickford. Illustrated discussion of tires and springs for automobiles. 1400 w. Autocar—Aug. 13, 1904. No. 64715 A.

White Car.

A Successful Steam Touring Car, and the Reasons of Its Success. Gives reasons why most steam cars are undesirable, and why the White Steam Car has retained its popularity. Ills. 1500 w. Auto Jour—Aug. 20, 1904. Serial. 1st part. No. 64658 A.

HEATING AND COOLING.

Electric Heating.

Electric Heating and the Field It Offers Central Stations. James I. Ayer.

Reviews the conditions that have affected the development of electric heating, and discusses how to popularize and successfully introduce this method. 5500 w. Cent Sta—Aug., 1904. No. 64342.

Ice Making.

An Efficient Ice Plant at East Hampton, N. Y. Illustrates and describes a 10-ton ice-making plant of the plate class that produced on a seven-day test, an average of 14.04 tons of ice per ton of coal, at the rate of 14.6 tons daily. 1800 w. Eng Rec —Aug. 6, 1904. No. 64277.

Ice Making and Refrigeration at Louisiana Purchase Exposition. Description and views of the 500-ton plant installed. 3000 w. Ice & Refrig—Aug., 1904. No. 64247 C.

Refrigeration.

Artificial Refrigeration. F. E. Matthews. An explanation of systems used, with illustrations. 2500 w. Power—Aug., 1904. No. 64195 C.

Refrigeration Standard.

Standard Unit Ton of Refrigeration. Description and views of plant and apparatus used for special tests made to determine the actual work accomplished by the refrigerating machine under conditions such as ordinarily prevail. 2700 w. Ice & Refrig—Aug., 1904. No. 64246 C.

HYDRAULICS.

Air Lift.

The Air Lift. Illustrated description of method of raising water by compressed air. 1500 w. Engr, U S A—Aug. 15, 1904. No. 64677 C.

Efficiency Trials of Air-Lift Pumping Plant. J. W. M. Richardson. Abstract of a paper read before the British Assn. of W.-Wks. Engrs. An illustrated description of the plant of the Birkenhead Corporation. 3000 w. Mech Engr—Aug. 20, 1904. No. 64659 A.

Centrifugal Pumps.

Tests of De Laval Centrifugal Pumps. Account of tests made by Prof. J. E. Denton and Prof. William Kent, at the works of the De Laval Steam Turbine Co., Trenton, N. J. 1800 w. Eng Rec—Aug. 20, 1904. No. 64502.

The De Laval Tigh-Pressure Centrifugal Pumps (Pompes Centrifuges de Laval à Haute Pression). K. Sosnowski. A fully illustrated report upon the combination system of centrifugal pumps arranged for direct connection with the de Laval steam turbine. 7000 w. Bull Soc d'Encour—June, 1904. No. 64463 G.

The Rateau Multicelular Centrifugal Pump for High Heads (Les Pompes Centrifuges Multicellulaires à Grande Elévation du Système Rateau). M. Rey. A fully illustrated account of the Rateau system, using a number of pumps in series, operated by electric motors, steam turbine, or hydraulic turbine. 8000 w. Bull Soc d'Encour—June, 1904. No. 64464 G.

Flow.

See Civil Engineering, Waterways and Harbors.

Impulse Wheel.

Efficiency Tests of an Impulse Wheel. Prof. Joseph N. LeConte. Preliminary article on methods employed and results obtained in tests of a 3-foot Pelton wheel at the Univ. of California. Illustrations and tables. 1500 w. Cal Jour of Tech—May, 1904. No. 64634 C.

Laboratory.

The Hydraulic Laboratory of the Technical High School at Darmstadt. (Das maschinenbau laboratorium III des Technischen Hochschule Darmstadt. Prof. A. Pfarr. Illustrating and describing the testing flume, weirs, pumping plant and hydraulic laboratory equipment at the Darmstadt Polytechnic. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 16, 1904. No. 64401 D.

Pulsometer.

The Pulsometer Steam Pump on Public Works. P. E. Hodgkin. Illustrated descriptions of this pump raising water in foundation and sewage work, baths, locomotive tanks and other purposes. 2500 w. Public Works—Aug. 15, 1904. No. 64648 D.

Rand Water.

See Mining and Metallurgy, Mining.

Turbines.

High-Pressure Water Wheels, with Particular Reference to the Girard and Francis Turbines. E. G. De Wald. Paper before the Pacific Coast Electric Transmission Assoc., giving a description of these turbines, with illustrations and diagrams. 2000 w. Jour of Elec—Aug., 1904. No. 64560 C.

Valves.

The Action of Spring-Loaded Pump-Valves (Die Wirkungsweise Federbelasteter Pumpenventile und ihre Berechnung). H. Berg. An exhaustive mathematical study of the action of pump valves, including the results of investigation with the indicator. Three articles. 12000 w. Zeitschr d Ver Deutscher Ing—July 23 30, Aug. 6, 1904. No. 64403 each D.

INTERNAL-COMBUSTION MOTORS.

Carburetters.

Carburetters. J. S. V. Bickford. An examination into the construction and function of the spray type of carburetter from the theoretical side. Ills. 2500 w. Engr, Lond—July 22, 1904. No. 64231 A.

Dry-Dock Plant.

Gas Power Plant at Elderslie Graving

Dock. Illustrated description of Crossley gas producer plant and gas engines, for operating pumps at Shearer's shipyard on the Clyde. 1000 w. Engr, Lond—Aug. 12, 1904. No. 64524 A.

Gas Power.

Power Installation at the Isle of Elba for the Utilization of Blast Furnace Gas. Emile Guarini. Illustrated description of an interesting example of the utilization of blast furnace gas for the production of power by means of gas engines and dynamos. 800 w. Power—Aug., 1904. No. 64193 C.

Gas Washer.

The Theisen Centrifugal Gas Washer. Illustrated description of apparatus for purifying gas from blast furnaces, etc., for use in gas engines. 700 w. Ir Age—Aug. 18, 1904. No. 64601.

Heysham Harbor.

See Civil Engineering, Waterways.

High-Speed.

High-Speed Internal-Combustion Engines. Illustrated descriptions of various light, gasoline engines, and of methods of ignition. Serial. Part 1. 3000 w. Engr, Lond—Aug. 12, 1904. No. 64523 A.

Oil Engines.

Oil Engines. H. B. Maxwell. Illustrates and describes some of the main types of the various oil engines. 1600 w. Marine Engng—Aug., 1904. No. 64171 C.

Ravel Motor.

See Mechanical Engng., Automobiles.

Waste Heat.

An Enquiry Into the Waste Heat from Gas Engines, with Some Suggestions for its Useful Application. George Chasser. Read before the Inst. of Heat & Ven. Engrs. at Liverpool. An investigation of heat losses, giving diagrams showing suggested arrangements of the apparatus. 4500 w. Plumb & Dec—Aug. 1, 1904. No. 64702 A.

MACHINE WORKS AND FOUNDRIES.

Bridge Works.

Clarke-Street Works, Derby. Illustrated description of these new works, which are an extension of the large plant of A. Handyside & Co., Ltd. 2200 w. Engr, Lond—July 29, 1904. No. 64323 A.

The American Bridge Company's Ambridge Works. Illustrated detailed description of the largest bridge plant in the world. 2500 w. Ir Age—Aug. 4, 1904. No. 64239.

Castings.

A Heavy Casting. Illustrates and describes a heavy casting made in Seattle, Wash., with the mold and method employed in pouring the same. 800 w. Foundry—Aug., 1904. No. 64261.

Chemistry.

Applied Chemistry in Foundry Work (Angewandte Chemie im Giessereibetriebe). Oskar Leyde. A discussion of the value of chemical analysis of foundry irons, and the economy to be effected by the general application of chemistry to the regular work of the foundry. Serial. Part I. 3500 w. Stahl u Eisen—July 15, 1904. No. 64428 D.

Cost-Keeping.

See Industrial Economy.

Dies.

Notes on Die Making. Frank E. Shailor. Illustrates a die containing several novel features, and describes the construction. 1600 w. Mach, N. Y.—Aug., 1904. No. 64198 C.

Electric Driving.

The Electric Equipment of Workshops and Factory Buildings. Percival Robert Moses. A discussion of the advantages of electric driving, with suggestions as to the choice of apparatus for various kinds of work. 3000 w. Engineering Magazine—September, 1904. No. 64485 B.

Emery Wheels.

The Mounting of Emery Wheels. Reproduction of remarks by Mr. Verney on the bursting of emery wheels and means of prevention, with figures. 1000 w. Mech Engr—Aug. 6, 1904. No. 64679 A.

Iron Works.

Mechanical Appliances in Iron Works Operation (Maschinelle Einrichtungen im Eisenhüttenwesen). Fr. Frölich. Discussing especially the various auxiliary machinery used in connection with the manufacture of iron and steel. The present instalment describes traveling ladles for hauling slag and molten metal. Serial, Part I. 3500 w. Zeitschr d Ves Deutscher Ing—Aug. 6, 1904. No. 64406 D.

The Lookout Mountain Iron Company. Description of the company's property and plant at Battelle, Ala. 3500 w. Ir Age—Aug. 4, 1904. No. 64241.

Jigs.

Flat Turret-Lathe Jigs. Descriptions and illustrations of jigs and fixtures used in the manufacture of the Jones & Lamson lathe. 1500 w. Am Mach—Vol. 27, No. 34. No. 64594.

Lathes.

Some Lathe Attachments for the Amateur Machine Shop. Robert G. Griswold. Illustrates and describes angle plates, facing attachment and grinding attachment, explaining methods of using. 2000 w. Am Mach—Vol. 27, No. 31. No. 64243.

The Le Blond Quick-Change Feed Lathe. Illustrated description of lathe equipped with quick-change gear box for feeding and thread cutting. 1200 w. Ir Age—Aug. 25, 1904. No. 64604.

Model Plant.

Model Plant of the New Britain Machine Company. Illustrates and describes a model example of the mill, type of construction applied to machine shop use. 3300 w. Mach, N. Y.—Aug., 1903. No. 64197 C.

Planers.

A Test of a Motor Driven Planer. J. C. Stern. An account of an interesting test, with diagrams. 800 w. Am Engr & R R Jour—Aug., 1904. No. 64201 C.

Electrically Driven Planer with Speed-Changing Countershaft. Illustrated description of Pond planer with Crocker-Wheeler motor. 1000 w. Am Mach—Vol. 27, No. 34. No. 64597.

Portable Tools.

Electrically-Driven Portable Tools. Dr. Alfred Gradenwitz. Illustrates and describes electrically-driven portable drills, and their applications. 1200 w. Mach, N. Y.—Aug., 1904. No. 64199 C.

Shops.

See Railway Engineering, Permanent Way; and Street and Electric Railways.

Shop Methods.

Some Gaging and Measuring Methods at the Works of the Westinghouse Machine Company. Illustrates instruments and describes the method of using them. 1800 w. Am Mach—Vol. 27, No. 31. No. 64242.

Spacing Attachment.

An Odd Spacing Attachment for the Milling Machine. A. Cashman. Illustrated description. 1000 w. Am. Mach—Vol. 27, No, 34. No. 64595.

Steel Plant.

Steel Plant of the Grand Crossing Tack Company. Illustrated detailed description of plant for the manufacture of wire rods, wire nails, and other wire products. 2400 w. Ir Age—Aug. 4, 1904. No. 64240.

Tools.

The Introduction of High-Speed Steel into a Factory. A. D. Wilt, Jr. Practical notes upon the difficulties encountered in the use of the new steels; including character of tools, methods of using, instruction of workmen, etc. 3000 w. Engineering Magazine—September, 1904. No. 64480 B.

MATERIALS OF CONSTRUCTION.

Alloys.

Stable and Unstable Equilibrium in Iron-Carbon Alloys (Labile und Metastabile Gleichgewicht in Eisen-Kohlenstoff Legierungen). E. Heyn. A study of the changes which occur among the iron-carbon alloys, illustrated with microphotographs. 5000 w. 1 plate. Zeitschr f Elektrochemie—July 22, 1904. No. 64455 F.

The Chemistry of Alloys for Naval Use. Translated from the *Revue de Chimie Industrielle.* Reviews various alloys used and the uses for which they are suitable. 1200 w. Stevens Ind—July, 1904. No. 64345 D.

Elasticity.

Researches in the Theory of Electricity (Weitere Untersuchungen über die Theorie der Elastizitat). F. Rust. A mathematical study of the elastic resistance of beams to transverse loads. 4000 w. Oesterr Wochenschr f d Oeff Baudienst—June 11, 1904. No. 64467 D.

Emery Wheels.

Experimental Work with Solid Emery Wheels. T. Dunkin Paret. Reports investigations and tests of emery wheels and the results. 6500 w. Jour Fr Inst—Aug., 1904. No. 64357 D.

Pipe Covering.

Testing Pipe Covering. George T. Hanchett. A brief description of a simple electrical method of testing. 1000 w. Cent Sta—Aug., 1904. No. 64341.

Shafts.

Is a Hollow Shaft as Strong and Durable as a Solid Shaft of the Same Diameter? If so, what is the Method of Manufacture and Proportion of Bore to Size of Shaft. Illustrated paper by Robert McF. Doble on the forging and treatment of steel, and discussion and letters by others. 10000 w. Pro Pacific Coast Ry Club—July 16, 1904. No. 64633 C.

Steel.

Special Steels for Automobile Construction (Spezialstähle für den Kaftkagenbau). Illustrating special shapes of steel of extreme strength and toughness especially intended for automobile construction. 2500 w. Stahl u Eisen—July 15, 1904. No. 64431 D.

Wire Rope.

Notes on the Theory of Wire Rope (Beiträge zur Theorie der Drahtseile). Dr. Hans Benndorf. A mathematical investigation of the relation of the resistance of a wire rope to that of the wires of which it is composed. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—July 22, 29, 1904. No. 64415 each D.

MEASUREMENT.

Decimal System.

Scheme for Decimalizing English Weights and Measures. Résumé of a pamphlet by Thomas A. Barber. 2000 w. Bul Int Ry Cong—July, 1904. No. 64320 E.

Impact Tests.

Tensile Impact Tests of Metals. W. Kendrick Hatt. Abstract of paper before the American Society for Testing Materials, with illustrations and tables, describing experiments made at Purdue University. 1400 w. R. R. Gaz—Vol. XXXVII, No. 11. No. 64627.

The Wanner Optical Pyrometer (Das Optische Pyrometer von Wanner). A general description of the instrument and its use, showing a high degree of accuracy in measuring temperatures above 900 degrees by the light emitted. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 6, 1904. No. 64439 D.

Pyrometers.

Pyrometers Suitable for Metallurgical Works. Abstract of a report prepared by a committee appointed by the Iron & Steel Inst. Ills. 4000 w. Elect'n, Lond—July 22, 1904. No. 64227 A.

Reichsanstalt.

The Work of the Reischsanstalt in 1903. Abstract of Director Kohlrausch's report on the testing and research work of the Physikalisch-Technische Reischsanstalt near Berlin. 4000 w. Engng—Aug. 5, 1904. No. 64512 A.

Rotating Disc.

The Stresses in a Rotating Disc (Die Spannungen in Einer Rotierenden Scheibe). C. Reimann. A mathematical investigation of the stresses set up in various parts of a flat disc when rotated at high velocities. 2000 w. Glasers Annalen—Aug. 1, 1904. No. 64412D.

Slide Rule.

Calculating Cone Steps and Back-Gearing Ratios by the Slide Rule. Robert A. Bruce. Description and diagrams showing use of slide rule in machine-tool design. 1,500 w. Am Mach—Vol. 27, No. 33. No. 64592.

Stator Deflection.

See Electrical Engineering, Generating Stations.

Testing Bureau.

The Royal Testing Laboratory at the Berlin Technical High School (Das Königliche Materialprüfungsamt der Technischen Hochschule Berlin). An editorial review of the new quarters of the Government testing bureau, with especial reference to its work upon iron and steel. 3500 w. Stahl u Eisen—July 15, 1904. No. 64429 D.

Testing Machine.

300-Ton Universal Testing Machine. Translation of article by M. Breuil in *Le Génie Civil,* giving a well illustrated account of a large testing machine built by Messrs. Joshua Buckton & Co., for Conservatoire des Arts et Métiers, Paris. 2200 w. Engng—Aug. 12, 1904. No. 64516 A.

POWER AND TRANSMISSION.

Cable Traction.

The Operation of Cars and Transfer Tables by Continuous Running Cables (Die Bewegung von Eisenbahnwagen und Schiebebühnen mittels stetig Umlaufenden Endlosen Seils). H. Glinz. Illustrating the use of an endless continuous running cable for hauling and transferring cars about a yard, using grip connections. Serial. Part I. 3500 w. Glückauf—Aug. 6, 1904. No. 64437 B.

Compressed Air.

Compressed Air in Quarrying. Claims economies obtained by substituting air for steam power. Ills. 1800 w. Mines and Min—Aug., 1904. No. 64300 C.

Power Transmission by Compressed Air. Lucius I. Wightman. Illustrates and describes a system at a North Amherst, Ohio, quarry, where the power is used by the same machines which originally were run by steam. 5000 w. Power—Aug., 1904. No. 64191 C.

Conveyor.

Electrically Operated Temperley Transporters. Illustrated description of coal handling apparatus for electric stations. 1200 w. Elect'n, Lond—Aug. 5, 1904. No. 64543 A.

The Kreiss Oscillating Conveyor (Die Kreiss Schwinge Förder Rinne). Prof. M. Buhle. Illustrating and describing a form of trough conveyor mounted on springs, and given an oscillating movement which cause the material to travel continuously in one direction. 1600 w. Glückauf—July 16, 1904. No. 64433 B.

Elevator Accidents.

Some Recent Elevator Accidents. Edward Van Winkle. Discussion with illustrations of elevator accidents in New York and the necessity for more careful inspection. 1500 w. Eng News—Aug. 25, 1904. No. 64609.

Gears and Springs.

Topical Discussion on Forms and Relative Advantages of Teeth in Gears. On cycloidal and involute teeth, and also on helical and elliptical springs. 4000 w. Pro Engrs' Soc of W. Pa—May, 1904. No. 64632 D.

Hotel Plant.

Mechanical Plant of the Hotel Lafayette, Buffalo. Description, with plan, of steam, electric, compressed air, refrigerating, heating, pumping and elevator plant. 1500 w. Eng Rec—Aug. 20, 1904. No. 64509.

Pneumatic Tools.

Compressed Air and Pneumatic Tools in Engineering Works. Frank Fielden. On the advantages and uses of compressed air in the shop. 2500 w. Engng—Aug. 19, 1904. No. 64666 A.

Power Plant.

The Power Plant of the Littleton

Creamery, Denver. Howard S. Knowlton. Describes an interesting plant for an establishment for the manufacture of butter, and the cold storage of butter, eggs, milk, cream and cheese. 2000 w. Eng Rec—Aug. 6, 1904. No. 64279.

Railway Shops.

See Railway Engineering, Permanent Way.

STEAM ENGINEERING.

Boilers.

Care and Management of Steam Boilers. William H. Fowler. The present number considers safety valves. Ills. 1500 w. Mech Engr—July 30, 1904. Serial. 1st part. No. 64307 A.

Mechanical Draught for Boilers. Walter Yates. Read at Liverpool, before the Inst. of Heat & Ven. Engrs., Considers the combustion of fuel, natural draught, and several forms of mechanical draughts. Ills. 4500 w. Elec Engr, Lond—July 29, 1904. No. 64311 A.

See also Marine and Naval Engineering.

Boiler Economies.

Boiler House Economies. Reginald S. Downe. Abstract of paper and discussion before the Incorporated Municipal Electrical Ass'n, reviewing the whole subject of efficient steam generation. Diagrams and tables. 7000 w. Elect'n, Lond—Aug. 5, 1904. No. 64544 A.

Engines.

The Murray Rolling Mill Engine. Illustrated detailed description of an exhibit at the St. Louis World's Fair. 1700 w. Ir Age—Aug. 11, 1904. No. 64350.

Feed-Water.

Greasy Condensation Water as Boiler Feed. William Paterson. Read before the Junior Inst. of Engrs. Discusses the consequences which result from the use of such water. Ills. 4000 w. Mech Engr —July 23, 1904. No. 64221 A.

The Deposit of Salts in Steam Boilers (Salzausscheidungen in Dampf Kesseln). Dr. Steger. Giving analysis of various waters, showing the extent to which the dissolved salts are decomposed in the steam boiler. 1200 w. Gesundheits-Ingenieur—July 20, 1904. No. 64419 B.

Fuel.

Smokeless and Economical Burning of Fuel. Charles Barter. Read before the Inst. of Heat & Ven. Eng. at Liverpool. A general survey of the subjects. 3000 w. Plumb & Dec—Aug. 1, 1904. No. 64703 A.

Hotel Plant.

See Mechanical Engineering, Power and Transmission.

Indicator Diagrams.

Diagrams from a Double Tandem Hoisting Engine (Diagramme einer Zwillings-Tandem Fördermaschine). Otto Himmelheber. A comparison of theoretical indicator diagrams with those obtained under actual working conditions. 1000 w. Zeitschr d Ver Deutscher Ing—July 23, 1904. No. 64405 D.

The Working Out of Indicator Diagrams. H. E. Hodgson. The present number discusses methods of finding the mean effective pressure. 1700 w. Elec Engr, Lond—July 22, 1904. Serial. 1st part. No. 64224 A.

Mechanical Draught.

Mechanical Draught for Boilers. Walter Yates. Paper before the Institution of Heating and Ventilating Engineers (British), giving descriptions and illustrations of mechanical draught apparatus. 3000 w. Mech Engr—Aug. 13, 1904. No. 64680 A.

Oil Fuel.

Boiler Trials with Oil Fuel at Los Angeles. A report of the acts of oil-burning water-tube boilers of the Babcock & Wilcox Co., and the Stirling Co. Ills. 2800 w. Eng Rec—Aug. 6, 1904. Serial. 1st part. No. 64287.

Oil Troubles.

Oil Dripping and Oil Slinging. Hereford Berry. An illustrated article discussing the causes and cures for these troubles. 1800 w. Am Mach—Vol. 27, No. 32. No. 64352.

Piping.

Pipe Connections (Ueber Rohrleitungen). A general discussion of steam piping and pipe connections together with plans of mains for batteries of steam boilers, according to the recommendations of the Dortmund boiler inspection association. 4500 w. Glückauf—July 30, 1904. No. 64436 B.

Piston Rods.

Piston Rods of High-Speed Engines. Ernest R. Briggs. Discussion of the use of Prof. Barr's formulæ in engine design, and particularly describing design of piston rods, with diagrams. 800 w. Am Mach—Vol. 27, No. 33. No. 64593.

Pumping Engine.

Pumping Engine for a Floating Dock. Illustrated description of the engines, and pumps for the Kobe floating dock, Japan. 900 w. Engr, Lond—July 22, 1904. No. 64230 A.

Steam Plant.

Design and Test of a Modern Steam Power Plant. Edward G. Hiller. Particulars of the construction and test of a modern factory steam plant, designed with the object of obtaining good commercial economical results. 9000 w. Ills. Inst of Mech Engrs—July 22, 1904. No. 64166 D.

Steam Turbines.

Steam-Turbine Construction. O. Lasche. A detailed account of experiments carried out by the Allgemeine Elektricitäts Gesellschaft, with illustrated description of various designs. 3000 w. Engng—Aug. 19, 1904. Serial. 1st part. No. 64665 A.

Superheating.

Recent Investigations upon the Specific Heat of Superheated Steam (Neuere Versuche über die Spezifische Wärme des Ueberhitzten Wasserdampfes). H. Lorenz. A comparison of the results of Carpenter and Jones with those of the author. 1000 w. Zeitschr d Ver Deutscher Ing—Aug. 6, 1904. No. 64408 D.

Superheated Steam for Locomotives in Germany. A report on the experiments in Germany with superheaters for locomotives, the types, and the conclusions. 4000 w. Ry & Engng Rev—Aug. 6, 1904. No. 64326.

Superheaters. Benjamin Taylor. Illustrates and describes some new types invented by W. H. Watkinson, giving results of practical tests. 3500 w. Power—Aug., 1904. No. 64192 C.

The Generation of Superheated Steam. Otto Berner. From the German as published in *Zeitschrift des Vereines Deutscher Ingenieure.* Facts deduced from experiments with superheated steam, considering the material required in the construction of steam superheaters, the transmission of heat, the velocity of steam through the pipes, and the work done by the boilers. 3500 w. Power—Aug., 1904. No. 64194 C.

The Principles and Practice of Superheating. W. H. Booth. General discussion of superheated steam and its use. 3000 w. Tram & Ry W'ld—Aug. 11, 1904. No. 64577 B.

Testing.

Design and Test of a Modern Steam Power Plant. Edward G. Hiller. Abstract of paper before the Institution of Mech. Engrs., giving an illustrated descriptive test of boilers and engines at the mills of Bessbrook Spinning Co., County Armagh, Ireland. 3500 w. Mech Engr—Aug. 6, 1904. Also Prac Engr—Aug. 5, 12 and 19, 1904. No. 64682 each A.

To Test for Blows in Valves, Cylinder Packing, Separate Exhaust Valve and Intercepting Valve. S. H. Draper. Suggestions for testing with discussion of causes of some engine troubles. 1500 w. Loc Engng—Aug., 1904. No. 64207 C.

Turbo-Generator.

See Electrical Engineering, Generating Stations.

Water Gauges.

Boiler Water Level Indicators. R. T. Strohm. Discusses gauge glasses, and try-cocks, also devices for closing communication with the boiler, etc. Ills. 2500 w. Am Elect'n—Aug., 1904. No. 64176.

MISCELLANY.

Aeronautics.

Sustaining Screw Propellers (Sur les Helices Sustentatrices). Edgar Taffoureau. An examination of the computations of Col. Renard, showing that the power required to sustain a weight has been underestimated. 1500 w. Comptes Rendus —Aug. 1, 1904. No. 64443 D.

The Dynamics of the Aeroplane (Notes sur la Dynamique de l'Aeroplane). M. Vallier. A mathematical study of the relations between the mechanics of the problem with the experimental laws of physics, taking into account the various speeds and powers of motors. 15000 w. Revue de Mécanique—July, 1904. No. 64460 E + F.

The Longitudinal Stability of Dirigeable Balloons (Ballons Dirigeables, Stabilite Longitudinale). Ch. Renard. A communication to the French Academy, discussing the use of auxiliary inflated cylinders attached to a cylindro-conical balloon to increase its stability. 1800 w. Comptes Rendus—July 18, 1904. No. 64441 D.

The Aeroplane. M. Rudolphe Soreau. Translated from *La Vie Automobile.* Extract from a lecture given before the French Soc. of Civ. Engrs., showing some of the difficulties met with in the construction of an aeroplane flying machine. 2200 w. Sci Am Sup—Aug. 27, 1904. No. 64651.

Galvanizing.

The Porter Galvanizing Process. Illustrated description of apparatus for removing the excess metal from galvanized articles. 1200 w. Ir Age—Aug. 18, 1904. No. 64600.

Invention.

See Industrial Economy.

Lock.

Development of the Star-Point Permutation Lock. Illustrated description of a new combination lock which is noiseless, can be worked in the dark, and is cheap to manufacture; the invention of Oberlin Smith. 4500 w. Am Mach—Vol. 27, No. 34. No. 64596.

Steam Shovels.

A Railway Steam Shovel of New Design. Illustrates and describes a new shovel designed by A. W. Robinson, noting the important changes. 2800 w. Eng News—Aug. 4, 1904. No. 64253.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

Sampling, Analyses and Preparation of Coal. F. R. Wadleigh. Many practical points on the analysis and testing of coal, with tables of proximate and ultimate analyses. 3000 w. R. R. Gaz—Vol. XXXVII, Nos. 11. No. 64626.

Belgium.

The Coal Basin of Northern Belgium (Le Bassin Houiller du Nord de la Belgique). Paul Habets. A commercial and geological account of the district with map and sections. 12000 w. 3 plates. Mem Soc Ing. Civ de France—May, 1904. No. 64444 G.

Briquetting.

The Briquetting Plant at Stockton, California. Robert Schorr. Description of a large plant for crushing lignite and making it into briquettes. 1000 w. Eng and Min Jour—Aug. 18, 1904.—No. 64393.

Coke Plant.

Segundo Coke Plant. R. M. Hosea. An illustrated description of the ovens and coal washing plant of the Colorado Fuel & Iron Co. 5000 w. Mines and Min—Aug., 1904. No. 64298 C.

Duluth.

The Zenith Furnace at Duluth. Dwight E. Woodbridge. Description, with illustrations, of a coke-oven gas plant, blast furnace, and coal dock of the most modern kind. 1500 w. Eng & Min Jour—Aug. 11, 1904. No. 64389.

Blast Furnace and By-Product Coke Plant of the Zenith Furnace Co. Illustrated description of a remodeled plant at Duluth, Minn. 2500 w. Ir Trd Rev—Aug. 11, 1904. No. 64354.

Ehrenfeld, Pa.

The Ehrenfeld Colliery. Description, with illustrations, of the electric plant and other features of coal mines near Johnstown, Pa. 2000 w. Eng & Min Jour—Aug. 18, 1904. No. 64391.

Handling Plant.

Coal Handling Plant at the Douglas Bank Colliery, Wigan. Illustrated description of coal picking, screening and loading plant. 1000 w. Ir & Coal Trds Rev—Aug. 12, 1904. No. 64693 A.

Mine Surveying.

See Civil Engineering, Measurement.

Spontaneous Combustion.

The Spontaneous Ignition of Coal. Alfred O. Doane. Discussion of the causes of, and remedies for, spontaneous ignition of coal. 1400 w. Eng News—Aug. 18, 1904. No. 64372.

COPPER.

Arizona.

The Mines of Prescott, Arizona. A general review of the mining industry of this district, including the United Verde and other copper, gold and silver mines. Illustrations. 2000 w. Eng & Min Jour—Aug. 11, 1904. No. 64385.

Notes on the Bisbee District, Arizona. Dwight E. Woodbridge. Account of copper mines and companies. 2000 w. Eng & Min Jour—Ang. 25, 1904. No. 64616.

The Mines of Clifton District, Graham Co., Arizona. General description of copper mines, with illustrations of smelting plants. 1000 w. Min & Sci Pr—Aug. 13, 1904. No. 64691.

California.

The Copper Mines of Shasta County, Cal. Dwight E. Woodbridge. An interesting account of mines which have yielded nearly $30,000,000 worth of copper, and over half the silver mined in California. 2800 w. Ir Age—Aug. 11, 1904. No. 64351.

Deposits.

The Present Condition of Copper-Mining in the South. Walter Harvey Weed. Ducktown (Tenn.) is at present the only producer of any magnitude in the south, but promising reports of many other districts are given. 2300 w. Mfrs Rec—Aug. 11, 1904. No. 64353.

Greene Consolidated.

The Greene Consolidated Copper Company. Dwight E. Woodbridge. Illustrated description of the copper mines aud reduction works of Cananea, Sonora, Mexico. 3000 w. Ir Age—Aug. 25, 1904. No. 64605.

Mansfeld.

Copper Smelting at Mansfeld. Translation of an article in *Metallurgie,* giving an account of metallurgical operations at this great German copper mine. 1500 w. Eng & Min Jour—Aug. 11,1904. No. 64388.

Metallurgy.

Notes on the Metallurgy of Copper, Lead and Zinc. Walter Renton Ingalls. A review of American metallurgical practice. 4200 w. Min Mag—July, 1904. No. 64185 C.

Refining.

The Pioneer Electrolytic Copper Refinery of the United States. An illustrated description of the works of the Balbach

Smelting and Refinery Co., in Newark, N. J. 2000 w. Elec-Chem Ind—Aug., 1904. No. 64328 C.

GOLD AND SILVER.

Amalgamation.

Pan Amalgamation at the "Minas del Tajo," Rosario, Mexico. A. E. Drucker. Description of ore treatment at these silver and gold mines, particularly with reference to the saving of mercury, with figures of forms of shoes for the settlers. 3000 w. Cal Jour of Tech—May, 1904. No. 64639 C.

Assaying.

Cramer's Assaying. L. S. Austin. A review of an old work on assaying by the Professor of Metallurgy at the Michigan College of Mines. 2500 w. Eng & Min Jour—July 28, 1904. No. 64163.

Australasia.

Australasian Gold Yield. Statistics of gold production of Australia and New Zealand for the first half of 1904, with comment. Tables. 800 w. Aust Min Stand—July 14, 1904. No. 64684 B.

Boundary District.

Notes on Mining and Smelting in the Boundary District, B. C. Frederick Keefer. Read before the Can. Min. Inst. Notes on the development of the system for mining low-grade ores, particularly as regards the quarrying and handling of ores, and of features connected with the smelting operations. Plate. 1000 w. Can Min Rev—July 31, 1904. No. 64189 B.

British Columbia.

Poplar Creek and Other Camps in the Lardeau District. Prof. R. W. Brock. On the development, geology, structure, deposits, and ores of this district. Gold, silver and other metals are found. 5500 w. B C Min Rec—Aug., 1904. No. 64338 B.

The Nickel Plate Mine and Other Promising Claims at Camp Hedley, Similkameen. George E. Winkler. An illustrated account of progress made in this valley in exploration and working of mines. Gold and other metals of value are found. 3000 w. B C Min Rec—Aug., 1904. No. 64337 B.

California.

The North Star Mines. An illustrated article giving information of the equipment and improvements of these gold mines near Grass Valley, Cal. 1800 w. Min & Sci Pr—Aug. 20, 1904. No. 64710.

Chlorination.

The Chlorination Practice in the Cripple Creek District. G. E. Wolcott. Description of the operations carried on at the Economic Mill, Victor, Colo. 1000 w. Min Rept—Aug. 11, 1904. No. 64687.

Cyanidation.

Present Practice of Cyanidation in the Black Hills. William Magenau. Tables giving details of the practice at various ore mills in South Dakota, both wet crushing and dry crushing, with descriptions and illustrations. Serial. 2 parts. 5000 w. Eng & Min Jour—Aug. 11 and 18, 1904. No. 64387 C.

Cyaniding Tailings at the Golden Jubilee Mine, in Trinity Co., Cal. W. W. Merriam. Description of gold ore treatment at a plant having a capacity of 25 tons a day. 3000 w. Cal Jour of Tech—May, 1904. No. 64641 C.

Idaho.

In Boise Basin, Idaho. Illustrated description of gold dredging, hydraulic mining, and of gold mines in this district. 1500 w. Eng & Min Jour—Aug. 25, 1904. No. 64617.

Laboratory Appliances.

A New Electric Furnace and Various Other Electric Heating Appliances for Laboratory Use. H. N. Morse and J. C. W. Frazer. Review of an article in the *Am. Chem. Jour.* Description with illustrations and reports of experimental investigations. 2500 w. Min Rept—Aug. 25, 1904. No. 64709.

Mexico.

The Guanajuato Mining District. Carl Henrich. An illustrated historical account of these silver mines, which have the largest output in the world. 3000 w. Min Mag—July, 1904. Serial. 1st part. No. 64186 C.

The Method Used in Working the Silver-Lead Mines of Santa Eulalia, Chihuahua, Mexico. Edward G. Cahill. Description of deep mining below abandoned upper workings, with illustrations of crystal formation in limestone caves, 2200 w. Cal Jour of Tech—May, 1904. No. 64638 C.

New Zealand.

Milling and Treatment of Auriferous Ores in New Zealand. H. A. Gordon. Abstract from paper in Trans. of the Australasian Inst. of Mining Engrs. 5000 w. N Z Mines Rec—June 16, 1904. No. 64685 B.

Rhodesia.

Mining Potentialities of the Zambesi Valley. Theo. F. Van Wagenen. The geography, mining laws, mineral wealth, etc., of Rhodesia, South Africa, with illustrations. Min & Sci Pr—Aug. 6, 1904. No. 64689.

Sampling.

Sampling Ore Shipments. W. J. Adams. Description of standard sampling methods used at ore-treatment works, and reasons for discrepancies between their assays and those of the mine owners. 2000 w. Min & Sci Pr—Aug. 6, 1904. No. 64690.

Sludges.

Recovery of Bullion from Zinc-Box Sludge. E. H. Taylor. From the Report of the Chamber of Mines, W. A. Notes on the economical uses of fluxes in the smelting of zinc-box sludges. 2000 w. Min & Sci Pr—July 30, 1904. Serial. 1st part. No. 64275.

Stamp Mills.

Stamp-Mill Practice in South Africa. F. C. Roberts. Illustrated account of gold ore-crushing methods in the Transvaal. 2400 w. Eng & Min Jour—Aug. 25, 1904. No. 64621.

Valuation.

Investigation and Valuation of Gold Mining Properties (Untersuchung und Wertberechnung von Goldbergwerken). S. Michaelis. A very complete account of a systematic method of investigating a gold mining property with a view of obtaining an accurate estimate of its value. Four articles. 7000 w. Oesterr Zeitschr f Berg u Hüttenwesen—July 16, 23, 30, Aug. 6, 1904. No. 64438 each D.

IRON AND STEEL.

Armor Plate.

The Manufacture of Armor Plate (La Fabrication des Plaques de Blindage). A. Bizot. An illustrated description of the Chaussade mills at Guerigny, France, where the armor plate for the French navy is made. 2000 w. 1 plate. Génie Civil—July 23, 1904. No. 64423 D.

Blast Furnaces.

Blast Furnaces in the Ural. J. Bicheroux. Abstract from a paper in the *Revue Universelle des Mines*. Describes prevailing conditions, the smelting plants, ores, etc. 1300 w. Eng & Min Jour—Aug. 4, 1904. No. 64256.

Classification.

The Classification of Iron and Steel. Albert Sauveur. Read before the Am. Soc. of Test. Mat. Gives some classifications proposed, with opinions and comments. 3300 w. Ir & Steel Mag—Aug., 1904. No. 64264 D.

Duluth.

See Mining and Metallurgy, Coal and Coke.

Gas Washer.

See Mechanical Engineering, Internal-Combustion Motors.

Iron Works.

See Mechanical Engineering, Machine Works and Foundries.

Limonite Ores.

Chemical Characteristics of Limonite (Brown Hematite) Iron Ores. F. Lynwood Garrison. Discussion, with analytical tables, of ores in the Paleozoic rocks of the Appalachian system., 1600 w. Eng & Min Jour—Aug. 18, 1904. No. 64392.

Phase Rule.

The Application of the Phase Rule to Mixtures of Iron and Carbon (Ueber die Anwendung der Phasenlehre auf die Gemische von Eisen und Kohlenstoff). Dr. Bakhuis Roozeboom. With diagram, showing the temperatures and carbon content corresponding to the various iron-carbon alloys. 1000 w. Zeitschr f Elektrochemie—July 22, 1904. No. 64454 F.

Shafts.

See Mechanical Engineering, Materials.

Steel Plant.

See Mechanical Engineering, Machine Works and Foundries.

See also Mechanical Engineering, Materials of Construction.

Stove.

The Hartman-Kennedy Fire-Brick Stove. John M. Hartman and John S. Kennedy. Illustrated description of three hot-blast stoves and equalizer for the blast-furnace plant of the Muscanetcang Iron Works, Stanhope, N. J. 500 w. Ir Age—Aug. 18, 1904. No. 64602.

Uintah.

The Iron Ores of the Uintah Mountains. A. W. Warwick. Description of deposits in the northeastern part of Utah. 1200 w. Min Rept—Aug. 18, 1904. No. 64688.

MINING.

Australia.

Mining Conditions and Progress in Western Australia. W. Burrell. Discusses wages and costs of ore treatment in Kalgoorlie. Ills. 1200 w. Mines & Min —Aug., 1904. No. 64304 C.

Boring.

Dover Colliery. An illustrated account of a system of percussive boring on an enormous scale, lining with complete rings of tubbing—the Kind-Chaudron system. 2500 w. Engr, Lond—Aug. 19, 1904. Serial. 1st part. No. 64663 A.

Cableways.

Cableway Conveyors for Mining Service (Neuere Drahtseilbahnen für Zechenbetriebe). G. Dietrich. Illustrating numerous installations of cable conveyors, both on the surface and in underground workings, in connection with electric driving. Two articles. 6000 w. Glückauf—July 23, 30, 1904. No. 64435 each B.

Drilling.

A Contract in Cleveland. Frank Seymour. Refers to the types of hand drill used in the early days of ironstone mining, and gives an illustrated description of the power drills now used. 3500 w.

Ir & Coal Trds Rev—Aug. 19, 1904. Serial. 1st part. No. 64661 A.

Electric Power.

Electrically Driven Mining Apparatus in Germany. C. L. Durand. Illustrated description of electric plants for hoisting, haulage, etc., at coal mines near Dortmund und Zwickau, Germany. 2000 w. Elec Rev, N. Y.—Aug. 20, 1904. No. 64541.

Hoisting.

A Veteran Hoisting Engine. E. R. Woakes. Illustrated description of a large hoisting engine installed at the Pozo Ancho mine of the Linares Lead Co., Ltd., Linares, Spain, in 1851. 350 w. Eng & Min Jour—Aug. 11, 1904. No. 64386.

Hoisting Drums. H. L. Auchmuty. Discusses methods of construction and the good and bad points of both metal-grooved and wood-logged drums. Ills. 1700 w. Mines & Min—Aug., 1904. No. 64301 C.

Hoisting Equipment of a French Colliery. L. Saclier. Abstract from *Revue Universelle des Mines*. Illustrated description of the arrangements at the Arenberg mine. 1800 w. Eng & Min Jour—Aug. 4, 1904. No. 64257.

Qualifications and Duties of a Hoisting Engineer. J. T. Beard. A consideration of some of the personal and educational requirements. 2300 w. Mines & Min—Aug., 1904. No. 64302 C.

Construction and Fencing of Hoists and Teagles. W. Sydney Smith. A report recently presented to the Home Office by H. M. Inspector of Factories, on the cause and prevention of accidents with hoisting machinery. Ills. 2300 w. Mech Engr—Aug. 20, 1904. Serial. 1st part. No. 64660 A.

Incline.

The Incline of the Atpoutley Coal Company. Walter H. Finley. Illustrated description of the apparatus for handling coal in cars from a high to a low elevation. 1200 w. Mines & Min—Aug., 1904. No. 64303 C.

Italy.

The Mines and Mineral Industries of Italy. Enrico Bignami. Describing especially the lead and zinc mines of Sardinia, with numerous illustrations. 4000 w. Engineering Magazine—September, 1904. No. 64483 B.

Japanese Mining.

A Great Japanese Mining Company. Benjamin Smith Lyman. An illustrated account of the Mitsui Mining Company, which mines coal, silver and other metallic ores and sulphur; but principally coal. 2000 w. Eng & Min Jour—July 28, 1904. No. 64162.

Mercur.

Mercur Mining Methods. George H. Dern. An illustrated article describing methods of handling the ores, drilling, timbering and blasting, giving some figures regarding costs of mining. 2800 w. Mines & Min—Aug., 1904. No. 64297 C.

Metalliferous Ores.

The Geographic Distribution of Metalliferous Ores Within the United States. Frederick Leslie Ransome. Facts concerning the distribution of the most important metals. 4000 w. Min Mag—July, 1904. No. 64184 C.

Mexico.

The Past and Present of the Mines of Mexico. G. C. Cunningham. A general account of the successful mining operations which have been conducted in Mexico, with information as to the methods of operation. 3000 w. Engineering Magazine—September, 1904. No. 64481 B.

Mine Explosion.

The Mine Explosion at Johnstown. M. G. Moore. A statement of the facts relating to the explosion of fire damp in the rolling mill mine of the Cambria Steel Co., July 10, 1902. 6000 w. Jour Fr Inst—Aug., 1904. No. 64356 D.

Mining.

Mining Past and Future. John A. Church. Reviews the history of the progress in mining copper, silver, gold, etc., in the United States, with comments on the future outlook. Ills. 2200 w. Min Mag—July, 1904. No. 64183 C.

Mining Laws.

Mining Laws of Mexico. Gives the most important sections of the mining law, which is considered very just, especially to foreigners. 9500 w. U S Cons Repts—June, 1904. No. 64293 D.

Power.

Transmission of Power. R. W. Chapman. Read before the Aust. Inst. of Min. Engrs. The present article discusses compressed air as a means of transmitting power from the surface to the workings. 2700 w. Aust Min Stand—July 7, 1904. Serial. 1st part. No. 64308 B.

Prospecting.

Sizing Up Prospects. Prof. Arthur Lakes. Remarks on the misleading assays of samples, and on things which should be regarded as indications as to value. 1800 w. Mines & Min—Aug., 1904. No. 64299 C.

Rand Water.

Water in the Witwatersand Mines. T. Lane Carter. Account of pumping acid water from the Transvaal gold mines, with diagram. 1500 w. Eng & Min Jour—Aug. 11, 1904. No. 64390.

Rock Crusher.

A Sectional Rock Crusher for Mining Work. Description, with illustrations of details of ore crusher weighing 7300 lbs., the heaviest parts only 300 lbs. 600 w. Eng News—Aug. 18, 1904. No. 64368.

Ropes.

Notes from the Westphalia Rope-Testing Station (Mitteilungen aus der Seilprüfungsstation der Westfälischen Berggewerkschaftskasse). H. Speer. With data and results of tests of a number of mine hoisting ropes. 2000 w. Glückauf—July 16, 1904. No. 64434 B.

Timbering.

Square-Set Practice at Bingham, Utah. Louis S. Cates. Illustrated description of timbering methods in copper mines with large bodies of low-grade ore. 2200 w. Eng & Min Jour—Aug. 25, 1904. No. 64619.

MISCELLANY.

Diamonds.

The Premier Diamond Mine. T. Lane Carter. General account of a large diamond mine in successful operation, 21 miles east of Pretoria, Transvaal. 2000 w. Eng & Min Jour—Aug. 25, 1904. No. 64623.

Diamonds in New South Wales. Llewellyn Parker. Description, with figures, of an occurrence of diamonds at Oakey Creek, near Copeton, whose source is a dike. 300 w. Eng & Min Jour—Aug. 25, 1904. No. 64622.

Magnesite.

Magnesite in California. Charles G. Yale. Brief description of deposits at Red Mountain and Porterville, and account of operating company. 800 w. Eng & Min Jour—Aug. 25, 1904. No. 64615.

Mercury.

The Metallurgy of Mercury. Dr. J. Ohly. General review. 1500 w. Min Rept—Aug. 11, 1904. No. 64686.

Nickel.

The Metallurgy of Nickel and Cobalt. Dr. J. Ohly. Concerning the applications, deposits, mode of treatment, &c. 2500 w. Min Rept—Aug. 4, 1904. No. 64305.

Petroleum.

Notes Regarding California Petroleum. Paul W. Prutzman. Paper before the Pacific Coast Gas Assoc., giving an account of production, refining, distillation and commercial products of California petroleum, with sketch map and diagrams. 7500 w. Jour of Elec—Aug., 1904. No. 64563 C.

Oil Fields and Petroleum Industry of Russia. Reports decrease in production, methods of operating, refining, transportation facilities, &c. 4300 w. U S Cons Repts—June, 1904. No. 64292 D.

Russian Petroleum. Prof. Edmond O'Neill. General account of the Baku fields and oil industry. 1200 w. Cal Jour of Tech—May, 1904. No. 64637 C.

The Mounds of the Southern Oil Fields. Lee Hager. Describes the geological structure and the conclusions reached, giving information of interest. Ills. 2200 w. Eng & Min Jour—July 28, 1904. Serial. 1st part. No. 64161.

Tin.

Tin Deposits of the York Region, Alaska. A. J. Collier. Abstract from Bulletin 229, U. S. Geol. Survey, describing the tin district on the Seward Peninsula. Serial. Part I. 1000 w. Min & Sci Pr—Aug. 13, 1904. No. 64692.

Tin Discoveries in the Bushveld. Account, taken from the *African Review,* of discoveries of rich veins of tin ore near Pretoria, Transvaal. 1000 w. Jour Soc of Arts—Aug. 5, 1904. No. 64569.

Tin Ore in North Carolina. Description, with illustrations and map of tin mines in North and South Carolina. 1000 w. Mining Wld—Aug. 20, 1904. No. 64683.

Tungsten.

Notes on Tungsten Deposits in Arizona. Forbes Rickard. Description, with illustrations, of veins and placers containing tungsten, in the Little Dragoon Mountains, and methods of working them. 3400 w. Eng & Min Jour—Aug. 18, 1904. No. 64394.

Zinc.

Notes on the British Columbia Zinc Problem. Alfred C. Garde. Read before the Can. Min. Inst. An explanation of the present situation in British Columbia, discussing the best methods for treating the extensive bodies of zinc-blende. 2500 w. Can Min Rev—July 31, 1904. No. 64188 B.

The Volumetric Determination of Zinc. Reviews the paper of W. George Waring in the *Jour. of the Am. Chem. Soc.,* giving extracts. 1200 w. Eng & Min Jour—July 28, 1904. No. 64160.

The Zinc Resources of British Columbia. A. C. Garde. Extracted from the *Lead and Zinc News.* Information showing that the zinc ores are worth mining for their zinc values. 2400 w. Can Min Rev—July 31, 1904. No. 64190 B.

Zinc Analysis.

The Determination of Lead, Iron, Lime, Sulphur, Cadmium and Copper in Commercial Zinc Ores. W. Geo. Waring. Description of analytical methods. 3000 w. Eng & Min Jour—Aug. 25, 1904. No. 64618.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in July. Detailed record. 2400 w. R R Gaz —Vol. 27, No. 10. No. 64383.

Clearance System.

Advantages of a Railway Clearance System. J. W. Midgeley. Review of attempts to establish a clearance system for cars and accounts; clearing yards the desideratum at crowded terminals. 3000 w. Ry & Engng Rev—Aug. 13, 1904. No. 64696.

Disinfection.

The Disinfection of Cattle Cars (Die Wirksame Desinfektion der Viehwagen). Adolf Freund. Showing the necessity of an effective disinfection of cars in which cattle have been carried, and advocating the use of chloride of lime. 4000 w. Gesundheits-Ingenieur—July 20, 1904. No. 64418 B.

Feeder Lines.

The Use of Motor Cars as Public Conveyances Acting as Feeders to Railways. A. Campiglio. Deals with steam cars and petrol cars, and their ability to meet such service, giving reports of applications, with costs. 4 tables. 8600 w. Bul Int Ry Cong —July, 1904. No. 64318 E.

Freight Handling.

How to Handle Freight Safely. R. C. Richards. Extracts from an address by the general claim agent of the Chicago & North Western R. R. to the agents of that company, giving much practical advice. Serial. 1st Part. 2500 w. R R Gaz—Vol. XXXVII., No. 11. No. 64629.

Railway Telephones.

The Telephone System of the Prussian-Hessian Railways (Der Streckenfernsprecher der Preussisch-Hessischen Eisenbahnen). Arthur Wilke. An illustrated description of the use of a telephone line system for the regulation and operation of a railway system. 2500 w. Glasers' Annalen—July 15, 1904. No. 64409 D.

MOTIVE POWER AND EQUIPMENT.

Cars.

Note on Increased Tonnage of Open Wagons and Increased Speed in Loading and Unloading Them. Mr. Schwabe, in *Zeitung des Vereins*. A discussion of the advantages, considering the subject in relation to the Prussian State Railway. 5 tables. 3200 w. Bul Int Ry Cong—July, 1904. No. 64319 E.

Note on the New 40-Ton Car of the Northern Railway of France (Note à Propos du Nouveau Wagon de 40 Tonnes de la Compagnie du Nord). Felix Sartiaux. A discussion of the advantages and disadvantages of large cars, showing the large gain from their use. 6000 w. Rev Gen des Chem de Fer—Aug. 1904. No. 64461 G.

100,000-lb. Coke Cars for the Chicago, Lake Shore & Eastern. Illustrated description of steel cars, built of commercial shapes, without continuous center sills. 700 w. R R Gaz—Vol. XXXVII., No. 10. No. 64382.

Car Wheels.

A Review of the Cast-Iron Wheel Situation. C. W. Gennet, Jr. Discussion of failures of wheels and improvements in form. 2000 w. R R Gaz—Vol. XXXVII., No. 9. No. 64381.

Couplers.

Automatic Couplers. William F. Pettigrew. Report to be presented at the session of the International Railway Congress, to be held in Washington, May, 1905. Ills. 3500 w. Ry Age—July 29, 1904. No. 64214.

On the Question of Automatic Couplers (Subject VII. for Discussion at the Seventh Session of the Railway Congress). William F. Pettigrew. Considers the advantages and disadvantages, the improvements effected in their construction, and their use with other couplers. For England. Ills. 5700 w. Bul Int Ry Cong—July, 1904. No. 64316 E.

Electrification.

Application of Electricity to Steam Roads. Prof. L. S. Randolph. Paper before the Richmond Ry. Club. Discusses the advantages and disadvantages of the electrical system. 4500 w. Ry & Engng Rev—July 30, 1904. No. 64216.

Explosion.

A Locomotive Explosion (Une Explosion de Locomotive). R. Bonnin. A fully ilustrated account and discussion of the serious explosion of the boiler of a locomotive at the St. Lazare station in Paris. 2500 w. Revue Technique—July 25, 1904. No. 64424 D.

Front Ends.

Front Ends and Steam. F. P. Roesch. Some particulars about front end conditions and the writer's views as to their design, &c. 1200 w. Loc Engng—Aug., 1904. No. 64208 C.

High Speed.

High-Speed Steam-Locomotive Tests in Germany. An account of the recent experiments made, describing the engines and giving the results. 1500 w. U S Cons Repts—June, 1904. No. 64296 D.

Locomotives.

A 4-4-2 High-Speed Machine on the Pennsylvania Lines. Illustrated description of an Atlantic type of engine for fast passenger work. 1100 w. Loc Engng —Aug., 1904. No. 64205 C.

Eight-Coupled Locomotive Built in Queensland. Illustrated description of 3 ft. 6 in. gauge freight locomotive built at Government workshops, Queensland, Australia. 500 w. Engr, Lond—Aug. 5, 1904. No. 64520 A.

German High-Speed Three-Cylinder Compound Locomotive. Illustrated description of locomotive and tender exhibited by Henschel & Son, of Cassel, at the St. Louis Fair. 1800 w. Ry & Engng Rev—Aug. 13, 1904. No. 64695.

Heavy Six-Wheel Switcher for the New York Central R. R. Illustrated description of locomotive built at the Schenectady Locomotive Works. 700 w. Ry & Eng Rev—Aug. 20, 1904. No. 64722.

New Locomotives for the Mexican Central Ry. Illustrates a 2-6-0 type as an example of the engines designed for this road. Description and dimensions. 800 w. Ry & Engng Rev—July 30, 1904. No. 64215.

The Development of the Compound Locomotive in England. W. E. Dalby. The first portion of a review of the growth of the compounding of locomotives on British railways, with many illustrations of important engines. 3500 w. Engineering Magazine—September, 1904. No. 64484 B.

The Engine Arrangement in Four-Cylinder Compounds. Gives a sketch indicating the arrangement in four types, with brief description of each design. 250 w. Ry Age—July 29, 1904. No. 64212.

The Mallet Articulated Locomotive at the St. Louis Exhibition. H. W. Hanbury. Well-illustrated description of large compound locomotive built by the American Locomotive Co. 1 Plate. 2000 w. Engng—Aug. 5, 1904. No. 64513 A.

Locomotive Tanks.

Fittings Around the Tank. James Kennedy. A criticism of the present methods, and statement of the evils they cause. 1000 w. Loc Engng—Aug., 1904. No. 64211 C.

Shoes.

Method of Laying Off Shoes and Wedges. John W. Percy. Drawing and explanation of method used in laying off shoes and wedges on offset frames where the rocker box and hanger on the fire box are in the way of the trams. 800 w. Loc Engng—Aug., 1904. No. 64206 C.

Transfer Table.

Electric Transfer Table (Chariot Transbordeur Electrique). M. Pouchucq. Illustrated description of transfer tables of the Western Railway of France, arranged to travel upon curves and upon straight tracks. 2500 w. Rev Gen des Chem de Fer—Aug., 1904. No. 64462 G.

Valve Gear.

The Walschaert Valve Gear. Editorial giving general description. 1000 w. Ry Age—Aug. 12, 1904. No. 64698.

PERMANENT WAY AND BUILDINGS.

Ecuador.

The Guayaquil & Quita Ry., in Ecuador, South America. John A. Harman. Illustrated description of the construction of a railway from the seacoast to the Andean plateau through very difficult country. 3500 w. 1 plate. Eng News—Aug. 11, 1904. No. 64361.

Egypt.

Egyptian Railway Administration Works at Cairo. An illustrated detailed description of the works and their equipment. 5300 w. Ry & Engng Rev—Aug. 6, 1904. No. 64325.

Freight House.

Concrete Block Freight House for the Chicago Great Western. Illustrated description of building at East Waterloo, Iowa. 400 w. R R Gaz—Vol. XXXVII., No. 11. No. 64630.

Panama.

Maintainance of Way on the Panama Railroad. Track, water tank with posts imbedded in concrete, and other features, with profile of road and illustrations. 1200 w. Ry Age—Aug. 19, 1904. No. 64720.

Roundhouse.

New Roundhouse and Coal Chutes for the Chicago Great Western Ry., at Oelwein, Iowa. Illustrated description. 1200 w. Ry & Engng Rev—Aug. 20, 1904. No. 64721.

San Pedro & Salt Lake.

Permanent Way and Structures of the San Pedro, Los Angeles & Salt Lake. General description, with illustrations of stations, viaduct, etc. 600 w. R R Gaz—Vol. XXXVII., No. 9. No. 64379.

Shop Plant.

Power Generation and Distribution at a Large Railroad Shop. Illustrated description of the plant of the large locomotive shop at East Moline, Ill. 2400 w. Elec Wld & Engr—July 30, 1904. No. 64235.

The Power Plant of the Rock Island Railway Shops at East Moline. Illustrates and describes a plant which includes steam, pneumatic, hydraulic and electric machinery. 3500 w. Eng Rec—July 30, 1904. No. 64181.

Shops.

Power Equipment of the New Shops of the Mexican Central Railway Company, Limited, Aguascalientes, Mexico. R. M. Henderson. Well illustrated account of buildings, power plant, electric distribution, etc. Serial. 2 parts. 7000 w. Elec Rev, N Y—Aug. 13 and 20, 1904. No. 64539 C.

Power Plant of the Mexican Central Shops at Aguascalientes. Illustrated description of steam and electric plant for railway shop. Serial. 1st part. 3500 w. Eng Rec—Aug. 20, 1904. No. 64506.

The Mexican Central Shops at Aguascalientes. Illustrated description of the shops and their equipment. 2500 w. R R Gaz—Aug. 5, 1904. No. 64290.

Shop Equipment. William S. Cozad. A criticism of the average railroad shop facilities. 2400 w. Am Engr & R R Jour—Aug. 1904. No. 64200 C.

Ideal Blacksmith Shop and Equipment for General Railroad Work. A. W. McCaslin. Extract of paper before National Assoc. of Blacksmiths. 1200 w. R R Gaz—Vol. XXXVII., No. 11. No. 64628.

See also Street and Electric Railways.

Signals.

Automatic Block Signals. Ralph Scott. Discusses the relative inherent advantages of each standard system. Ills. 2500 w. Am Elect'n—Aug., 1904. No. 64175.

Electric Interlocking. A letter from L. Weissenbruch, of the Belgian State Rys., referring to a former article of his on the Antwerp interlocking plant, with diagrams and editorial comment. 3000 w. Ry Age—Aug. 12, 1904. No. 64697.

Stations.

New Station of the Lackawanna at Roseville Avenue, Newark. Illustrates and describes a new station made necessary by the change of grade. 600 w. R R Gaz—July 29, 1904. No. 64165.

New Stations on the St. Louis & San Francisco. Gives plans and illustrated descriptions of some of the designs. 1200 w. R R Gaz—Vol. XXXVII., No. 8. No. 64288.

Terminals.

Substructure for the New Union Station, Washington. Illustrated description of the substructure of an important terminal, which consists entirely of concrete piers and walls. 2800 w. Eng Rec—Aug. 6, 1904. Serial. 1st part. No. 64276.

Passenger Terminal at Long Island City. General description, with illustrations of yard and tracks and Westinghouse electropneumatic interlocking switch and signal system. 1 plate. 1300 w. R R Gaz—Vol. XXXVII., No. 9. No. 64378.

Track.

The Pennsylvania Railroad's Track Construction for City Streets. Illustrated description of track construction in Philadelphia, with girder rails weighing 141 lbs. per yard. 300 w. Eng Rec—Aug. 20, 1904. No. 64507.

Trestles.

See Civil Engineering, Bridges.

Tunnels.

See Civil Engineering, Construction.

Turnouts.

A Problem in Locating Turnouts. C. M. Kurtz. Illustrated description of practical method for laying out railroad tracks, having regard to the angle of the frog at the turnout. 500 w. Eng News—Aug. 25, 1904. No. 64612.

Tyrol.

The Mendel Railway (Die Mendelbahn). K. Jordan. An illustrated description of the combined adhesion and cable railway over the Mendel Pass in the Austrian Tyrol. Two articles. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—July 29, Aug. 5, 1904. No. 64416 each D.

TRAFFIC.

Freight Rates.

On the Question of Slow Freight Rates (Subject XIII. for Discussion at the Seventh Session of the Railway Congress). Harry Smart, for England. Explains the general principles with description of different systems of rating slow freight goods. 3300 w. Bul Int Ry Cong—July, 1904. No. 64317 E.

Fruit Traffic.

The Tropical Fruit Traffic. Describes the methods, shipments and railroad facilities for caring for the fruit, especially bananas. 1800 w. Ills. R R Gaz—Vol. XXXVII., No. 8. No. 64289.

Pooling.

Pooling Locomotives—Double and Multiple Crews. Camille Boell. Report to be presented at the Int. Ry. Cong. in Washington May, 1905. Report based on information from 26 roads, with conclusions. 3300 w. Ry Age—Aug. 5, 1904. No. 64324.

MISCELLANY.

Fire Protection.

Railway Property and Fire Protection. An illustrated article discussing principally fire-extinguishing machinery. 3500 w. Transport—July 15, 1904. No. 64167 A.

Missouri Pacific.

The Growth of the Missouri Pacific. Reviews the history of this road and its development. 2000 w. R R Gaz—July 29, 1904. Serial. 1st part. No. 64164.

Mountain Railway.

The Mount Pilatus Railway, Switzerland. Emile Guarini. An illustrated account of this road and the combined locomotive and car which is used to climb to an altitude of 6,800 feet, on a track 15,150 feet in length. 2000 w. Sci Am—Aug. 13, 1904. No. 64355.

Siam.

Siamese Railway Tenders. Gives copies of specifications and conditions for tender on rolling stock and accessories for the royal Siamese State railways. 2800 w. U S Cons Reports—June, 1904. No. 64294 D.

Statistics.

The Railways of the World (Die Eisenbahnen der Erde). A tabulated statement of the railways of the world by countries, showing the mileage, growth since 1898, and relation to area and population. 2000 w. Stahl u Eisen—July 15, 1904. No. 64432 D.

Switzerland.

The Nationalization of Swiss Railways. A. Achard. Reviews the circumstances which made it seem desirable for the State to acquire the principal lines of railway, the measures by which the way was prepared, the method in which the work of purchase was carried out, and the results thus far. 7000 w. Trac & Trans—Aug., 1904. Serial. 1st part. No. 64347 E.

Uganda.

The Uganda Railroad. Review of the final report of the committee appointed to supervise the building of this road from Mombasa, on the east coast of Africa, 584 miles to Victoria Nyanza, giving general account of the construction and the present traffic returns. 1200 w. R R Gaz—Vol. XXXVII., No. 11. No. 64624.

STREET AND ELECTRIC RAILWAYS

STREET AND ELECTRIC RAILWAYS.

Barrow-in-Furness.

The Tramways in Barrow-in-Furness. Illustrated description of track cars, and other features of an English electric railway. 1600 w. Tram & Ry Wld—Aug. 11, 1904. No. 64573 B.

Buenos Aires.

Notes on Street Railway Systems of Buenos Aires. Guillemo A. Puente. Statistics and illustrated description of power station and other features. 1600 w. St Ry Rev—Aug. 20. 1904. No. 64571 C.

Canal Traction.

A Review of the Present State of Mechanical Canal Traction. F. H. Davies. Considers the advantages and disadvantages of the system tried, concluding in favor of electrical tractors. 4000 w. Elec Engr, Lond—Aug. 19, 1904. No. 64670 A.

Cars.

A Remarkable Combination Semi-Convertible and Convertible Car for City Service. Illustrated description of a car for the Montreal Street Railway. 700 w. St Ry Jour—Aug. 6, 1904. No. 64272 C.

Body Framing of Modern Interurban Cars. Edward C. Boynton. Illustrated description. 700 w. St Ry Jour—Aug. 13, 1904. No. 64566 C.

Electric Car with Six-Wheel Trucks and Motors of 800 Horse Power. Illustrated description of large car built by the John Stephenson Co. 500 w. Eng News—Aug. 25, 1904. No. 64611.

Extensive Improvements in Elevated Car Equipments—Brooklyn Rapid Transit Company. Illustrated description of new platforms, brake rigging, electric equipment, fireproofing, and other features. Serial. 2 parts. 8000 w. St Ry Jour—Aug. 13 and 20, 1904. No. 64564 each C.

Side-Door Coaches for World's Fair Service. Charles Alma Byers. Brief description with illustrations. 500 w. Sci Am—Aug. 27, 1904. No. 64650.

The New Type of Elevated Car Without Platforms, Boston Elevated Railway Company. Illustrated description. 1000 w. St. Ry Jour—Aug 6, 1904. No. 64271 C.

Compulsory Traffic.

Tramways and Compulsory Running Powers. Thomas Upton. Discusses the decision of the British Parliament to grant to a public company compulsory running powers over a portion of a certain municipal tramway. 3000 w. Elec Rev, Lond—July 29, 1904. No. 64313 A.

Darlington.

Electric Traction at Darlington. Illustrated description of track, power-house and other features of an English electric road. 2000 w. Tram & Ry Wld—Aug. 11, 1904. No. 64574 B.

Derby.

The Derby Electric Tramways and Electricity Supply. Illustrated description of large electric power house and railway system in England. 1800 w. Elec Engr—Aug. 12, 1904. No. 64556 A.

Dubuque, Iowa.

A Large New Steam Turbine Power Plant Installation for Dubuque, Iowa. Description and plans of a proposed power plant planned for the exclusive use of steam turbines. 5500 w. St Ry Jour—Aug. 6, 1904. No. 64269 C.

Electrification.

Application of Electricity to Steam Roads. L. S. Randolph. Paper before the Richmond Railroad Club, containing a general discussion of the subject. 4000 w. Elec Rev, N Y—Aug. 13, 1904. No. 64540.

Electrification of Steam Railways in England. Philip Dawson. General discussion. 2000 w. Ry Age—Aug. 19, 1904. No. 64719.

Glasgow.

The Glasgow Tramways. A review of the operation, traffic, finances, etc., of 70 miles of double-track surface electric railway, serving about 1,000,000 population. 3000 w. Engr, Lond—Aug. 12, 1904. No. 64522 A.

Incline.

The Palermo-Monreale, Italy, Incline System. C. L. Durand. Illustrates and describes a line operated by electricity having some interesting features. 1700 w. Elec Rev, N Y—Aug 6, 1904. No. 64274.

Instruction Car.

Instruction Car on the New York Subway. Illustrated description of car and method of instructing 3000 motormen in anticipation of the opening of the rapid transit road. 1500 w. St Ry Jour—Aug. 20, 1904. No. 64568 C.

Lackawanna & Wyoming.

The Lackawanna & Wyoming Valley Railroad. D. A. Willey. Illustrated description of an interesting electric road between Scranton and Wilkesbarre, which represents the most advanced type of third rail electric traction yet completed in the United States. 2000 w. Elec Rev, N Y—Aug. 27, 1904. No. 64708.

Leicester.

Leicester Corporation Electric Tramways. E. G. Mawbey. Detailed description of an English electric railway. The first part is devoted chiefly to the power station. Illustrations and map. Serial. Part I. 4000 w. Public Works—Aug. 15, 1904. No. 64645 D.

Light Railways.

The Application of Electric Traction to Light Railways. H. Luithlen. Abstract of a report to be presented at the Vienna meeting of the International Tramways and Light Railways Association. Considers the advantages of electric traction over steam for light railway service. 2000 w. St Ry Jour—Aug. 27, 1904. No. 64706 C.

London.

Metropolitan Electric Tramways. General description, with outline map, of electric surface railways in the northern part of London. 1600 w. Tram & Ry Wld—Aug. 11, 1904. No. 64575 B.

Multiple-Unit.

Sprague's Multiple Unit System of Electric Traction. Report of the Committee on Science and the Arts on the invention of Frank J. Sprague. 1200 w. Jour Fr Inst—Aug., 1904. No. 64360 D.

The Westinghouse Unit-Switch System of Multiple-Unit Train Control. Illustrates and describes the method of controlling the driving power as exemplified in this system. 2500 w. Elec Engr, Lond—July 29, 1904. No. 64309 A.

Municipal Ownership.

City-Owned Street Cars. Walter C. Hamm. On the municipalization of the street car system of Hull, England. How it was accomplished, the mode of operation, and the success. 2200 w. Eng Rec—Aug. 6, 1904. No. 64286.

Newcastle.

Descriptive Account of the Newcastle Corporation Tramways System. A. E. Le Rossignol. Read before the Incor. Assn. of Munic. & Co. Engrs. Ills. 2000 w. Elec Engr, Lond—July 22, 1904. No. 64222 A.

New York Central.

The New York Central Plans in the Center of New York. An account, based on an interview with H. E. Andrews, of plans for consolidating electric roads and electrifying portions of steam roads. 1800 w. St Ry Jour—Aug. 13, 1904. No. 64567 C.

Northampton.

Northampton Corporation Electric Tramways. General illustrated description of power house, track and other features of an English electric railway. 2000 w. Elec Engr, Lond—Aug. 5, 1904. No. 64554 A.

Ohio.

The Springfield, Troy & Piqua Railway Co. Illustrated description of the line, power house and substation equipments and rolling stock of a recently opened Ohio interurban electric railway. 3000 w. St. Ry Rev—Aug. 20, 1904. No. 64572 C.

Operation.

The Operative Costs of Tramways and the Builder's Guarantees (Die Unterhaltungs kosten bei strassenbahnen und die Garantie der Baufirma). A. Hecker. A discussion of the elements of traffic, distance, frequency of trips, etc., upon which estimates of operating costs are based. 2500 w. Elektrotech Zeitschr—July 28, 1904. No. 64450 B.

Paris-Orleans.

The New Locomotives and Motor Cars for the Paris-Orleans Railway Co. M. Vingoe. Description, with illustration of track. 900 w. Elect'n, Lond—Aug. 12, 1904. No. 64547 A.

Raworth System.

Raworth's Traction Patents. Account of successful demonstration of Raworth's system of automatic regenerative control for electric cars, the motors being compound wound, the series coils being used for emergency purposes and the shunt for normal. Diagrams and tables. 2000 w. Elec Rev, Lond—Aug. 12, 1904. No. 64552 A.

Shops.

New Car House and Shops for the Twin City Rapid Transit Company. Illustrated description of new buildings at St. Paul, Minn., in process of construction. 1400 w. St. Ry Jour—Aug. 27, 1904. No. 64705 C.

Single-Phase.

Compensated Motor Railway Equipment of the General Electric Company. Illustrated description of electric motors and other equipment of a new single-phase road, the Ballston division of the Schenectady railway. 1600 w. Elec Wld & Engr—Aug. 27, 1904. No. 64727.

Compensated Single-Phase Motor of the General Electric Company. Illustrated description with report of the recent test on the Ballston Division of the Schenectady Railway Company. 2500 w. St Ry Jour—Aug. 27, 1904. No. 64704 C.

The First American Single-Phase Railway in Commercial Operation; The General Electric System on the Ballston Line of the Schenectady Ry. Co. Illustrated description of line, cars and apparatus. Also, editorial. 4500 w. Eng News—Aug. 25, 1904. Also R R Gaz—Vol. XXXVII., No. 11. No. 64610.

The Operation of the Single-Phase Motor on the Niederschöneweide-Spindlersfeld Line (Der Betrieb mit Einphasigem Wechselstrom auf der Strecke Niederschöneweide-Spindlersfeld). H. von Glinski. Detailed description of the motor, made by the Union Elektrizitäts-Gesellschaft, and diagrams showing the results of tests. 3000 w. Glasers Annalen—August 1, 1904. No. 64411 D.

Statistics.

Statistics of Electric Railways in Germany (Statistik der Elektrischen Bahnen in Deutschland). The usual yearly tabulated report, showing very fully the growth of electric railways in Germany, with editorial comments. 15000 w. Elektrotech Zeitschr—July 21, 1904. No. 64448 B.

Storage Batteries.

The Storage Battery as Applied to Electric Railways. W. E. Winship. Considers their installations in central and substations, showing their utility. 2200 w. Jour Fr Inst—Aug., 1904. No. 64358 D.

Subway.

The New York Rapid-Transit Subway. H. C. Fyfe. A fully illustrated description of the subway just completed in New York City, describing the location, construction and details of operation. 5000 w. Engineering Magazine—September, 1904. No. 64479 B.

Third-Rail.

Changes in the Baltimore and Ohio Locomotive Pick-Up Device. Illustrated description of an improved pick-up compressor installed on the cab. 1500 w. St Ry Jour—July 30, 1904. No. 64203 C.

Extension of the Third-Rail System of the Paris-Orleans Railway. An illustrated account of this work, with explanation of its aim. 3500 w. St Ry Jour—Aug. 6, 1904. No. 64268 C.

Inverted Third Rail Upon the Brooklyn Bridge. An illustrated description of an innovation in electric third-rail arrangement. 1300 w. St Ry Jour—July 30, 1904. No. 64202 C.

Third-Rail Heating.

A Third-Rail Electric Heating System. William Greenow, Jr. Description of a method for keeping the third rail free from ice by heating it with an auxiliary electric wire placed under the rail head, but insulated from the rail. 1000 w. R R Gaz—Vol. XXXVII., No. 10. No. 64384.

Traffic.

Analysis of Traffic and Methods of Development. Henry W. Brooks, Jr. Suggestions as to methods of stimulating traffic. 4000 w. St Ry Jour—July 30, 1904. No. 64204 C.

Tramcars.

Tramcar Design and Construction. Elmer E. Cook and T. C. Elder. On the importance of first-class construction, discussing present day types. Ills. 3200 w. Trac & Trans—Aug., 1904. Serial. 1st part. No. 64346 E.

Underground.

Chicago's Underground Freight Railroad. Illustrated detailed description of this tunnel, with statement of its purpose, methods of construction, motive power, equipment, method of handling trains, &c. 5000 w. Ir Age—Aug. 4, 1904. No. 64238.

Valve Handles.

Automatic Valve Handle Returning Device. Illustrated description of a device invented by A. Gottschalk, for automatically returning the handle of the motorman's brake valve after the maximum train line pressure of 70 lbs. has been accumulated. 600 w. Loc Engng—Aug., 1904. No. 64209 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
American Shipbuilder. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brick Builder. *m.* Boston.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Cassier's Magazine. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.

Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Page's Magazine. *m.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Public Works. *m.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Conversion Tables.

Ready Reference Tables. Volume I. Conversion Factors of Every Unit or Measure in Use. By Carl Hering, M. E. Size, 7 by 4 in.; pp. xviii, 196. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Although there have been innumerable tables and compilations of units and measures and of their equivalent values in different systems, the present volume, which is the first of several having data conveniently arranged for ready reference, contains the most complete and accurate collection of measures and their interconversion factors that has probably ever been brought together. These conversion factors have all been especially recalculated, under the direction of the author, from the exact legal values, and from the most standard and authoritative values where no legal ones exist. The fundamental values were obtained from the U. S. National Bureau of Standards and similar bodies, by whose officials they were checked after the pages had been electrotyped. All the conversion factors were calculated from the same set of fundamental values, so that they are all consistent with each other and form a single, interconvertible, uniform system. Seven-place logarithms of nearly all the conversion factors are given, as well as approximate values of the principal ones. In the introductory part there is a discussion of the interrelation of units, the distinction between units and quantities, and similar questions, and there is a table of physical quantities, giving the derivation, symbols, dimensional formula, and other data concerning each. There is a most complete and up-to-date collection of the electric, magnetic and photometric units, with explanations of them all, and tables showing their interrelations. Compound units and their conversion factors are given, as well as thermometer scales, monetary tables, and a complete index. Altogether, this work appears to be practically exhaustive, and one has a refreshing feeling of security in dealing with figures which are founded on such reliable authorities, and are so accurate and consistent.

Corporations.

Moody's Manual of Corporation Securities. Fifth Annual Number, 1904. John Moody, Editor; C. L. F. Bridge and Louis W. Holschuh, Associate Editors. Size, 9 by 6 in.; pp. 2372. Price, cloth, $10; flexible leather, $12. New York and Chicago: Moody Publishing Co. London: Effingham Wilson.

There is so much loose talk and writing about the "trusts" and great companies which exercise such a tremendous influence in our affairs and touch the lives of the people at every point, that it is refreshing to get away from generalities, which are usually anything but glittering, and learn some reliable facts concerning these corporations. The present volume affords such an opportunity, for it is crammed with statistics of the corporations and financial institutions of America, so well arranged and so carefully indexed, that any information sought may be found at once. This edition of Moody's Manual is an advance on all previous ones. Special efforts have been made to elaborate the sections devoted to steam railroads and other public service corporations; in the lists of railroad bonds the complete and uniform descriptions of mortgages are supplemented by maps of some of the railroad systems. The industrial section is very comprehensive and full of interest. In all divisions of the work each corporation has statistics given concerning the property owned and controlled by it, its capitalization and bonded debt, dividends paid, financial condition and earnings, officers, managers and directors, location of plants and offices, and so on. The contents are arranged in eight sections, containing, respectively: Membership lists of all the stock exchanges of the United States and Canada; statistics of American and foreign government and State securities; steam railroad corporations of the United States, Canada and Mexico; gas, water, electric light and electric railway corporations in these countries; telephone, telegraph and cable corporations; industrial and miscellaneous corporations; mining and oil corporations; banks, trust companies and other financial institutions.

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

Vol. XXVIII. NOVEMBER, 1904. No. 2.

THE BUILDING OF A CHINESE RAILWAY.

By Justin Burns.

An article by Mr. Thos. H. Reid on "Railway Making in China," which we published in December, 1903, dealt chiefly with the economic side of the development and the general features of the projected enterprises. The account by Mr. Burns, which we now present, is concerned with the practical work of carrying out the construction, and has the peculiar interest which attaches to a record by one who has been in actual charge of the building of the line and the handling of the novel problems presented by the country and the people.—The Editors.

CHINESE SOLDIERS.

THE material development of internal resources and communications in China followed the war with Japan in 1895. Within the preceding quarter of a century, railroad construction had made a beginning, yet there were only a few miles of line in operation; telegraph systems were fairly well established, connecting the important provinces; but it was not until after being thoroughly defeated by Japan that China awakened to the possibility of the presence of some element of weakness in her organization. The self-glorification and self-satisfaction had been so intense in the previous years that she was blind to all things outside the walls of the Celestial Kingdom; but when she discovered her inability to

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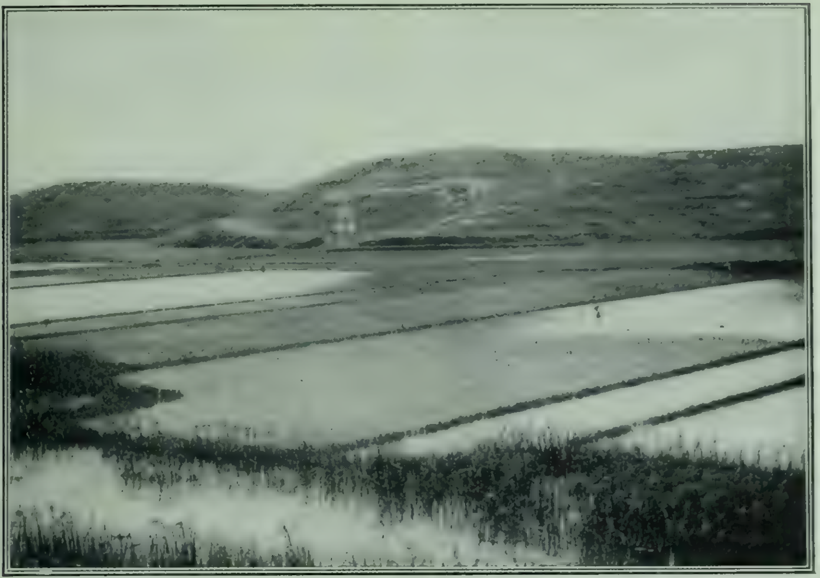
move or concentrate her troops or to replenish stores from distant provinces, the immense advantages of communication by railroad began to dawn upon the minds of the officials. It was then that the first real impetus was given to the construction of railroads in China. At that time, the only ones in existence were the few miles of track from Shanghai to Woosung and the few hundred miles from Tientsin to Manchuria. Peking was still isolated, the communication being only by cart or junk.

For the improvement of internal conditions, departments of railways were established; but on account of the drain upon the resources at that period it was necessary to depend upon foreign capital to develop this most important element in the future welfare of the Empire. For various reasons of favor or influence, concessions for railroads connecting principal cities and provinces were given to different nationalities. A small amount of work was attempted by the Imperial Chinese Railway Administration without the aid of foreign capital, but this construction could not be otherwise than slow and inferior. The foreign railway influence caused by the distribution of concessions could be generalized by stating that the Russian was dominant in the north beyond Peking; the German in the northeast

A NATIVE CHINESE BRIDGE. SHOWING THE USE OF THE ARCH.



AN ILLUSTRATION OF THE COUNTRY ON THE SOUTHERN END OF THE CANTON HANKOW LINE. INUNDATED RICE FIELDS, SHOWING GRAVES IN THE BACKGROUND.

in the Shan Tung Peninsula; the British in the middle east adjacent to Shanghai; the French in the isolated southwest; the Belgian in the north middle, southward from Peking; and the American in the south middle, northward from Canton. Of the many concessions, it is generally admitted that the line from Canton to Hankow is one of the most valuable, on account both of its traversing provinces rich in mineral wealth and agricultural products, and of its forming a most important link in the vast continental system which will connect the eastern with the western world.

The American concession granted to the American China Development Company, is known as the Canton-Hankow Railway (Yueh-Han) which will connect the above named cities by a railroad of about seven-hundred miles in length. The line, whose general direction is almost due north, passes from Canton northerly along the east bank of the Pearl River across the low divide to the east bank of the North River (Pak Kong) which it follows for about two-hundred miles; the railway crosses the Chi Ling range of mountains into the valley of the Yang Tse Kiang, on the east bank of the Siang River, and follows this stream till near the Yang Tse where it bears off slightly to the eastward, following the right bank of that river to Hankow. Included with the concessions for the main line from

ON THE NORTHERN END OF THE LINE. VIEWS ON THE PAK KONG OR NORTH RIVER.

Canton to Hankow is the grant to construct a short line westward from Canton for a distance of thirty miles, establishing rail communication between the treaty ports of Sam Shui and Canton.

A LOCATING PARTY. AMERICAN ENGINEERS, CHINESE MANDARINS, ASSISTANTS, AND GUARDS.

The preliminary steps toward actual construction were taken in March, 1902, by the arrival in China of the officials of the American China Development Company. The location surveys were begun that fall, but ground was not broken for construction until March, 1903. To Americans who are accustomed to the rapid completion of railroad construction this delay in the actual commencement of the turning of earth into embankments seems inexplicable, but it is ignorance of the conditions that exist in the strange country of China which prevents the proper conception of the difficulties and obstacles encountered. The mere fact that the government at Peking grants permission for a foreign company to engage in an enterprise protected and vouched for by the Chinese Emperor is a simple factor in the problem. The difficulties in satisfying the crown appointees in charge of internal communications, the viceroys of the provinces, the lessor officials of controlling influence, do not appeal to a westerner until he has spent his weary weeks or months awaiting the confirmation of the already given approval. The consent, the influence, the assistance (passive or active) of the officials are obtained in various ways. The engineer who combines with his technical qualifications those of the diplomatic service will find need of every resource to make a success of the Oriental enterprise entrusted in his charge. The friendship of the local officials of the province or district is essential for

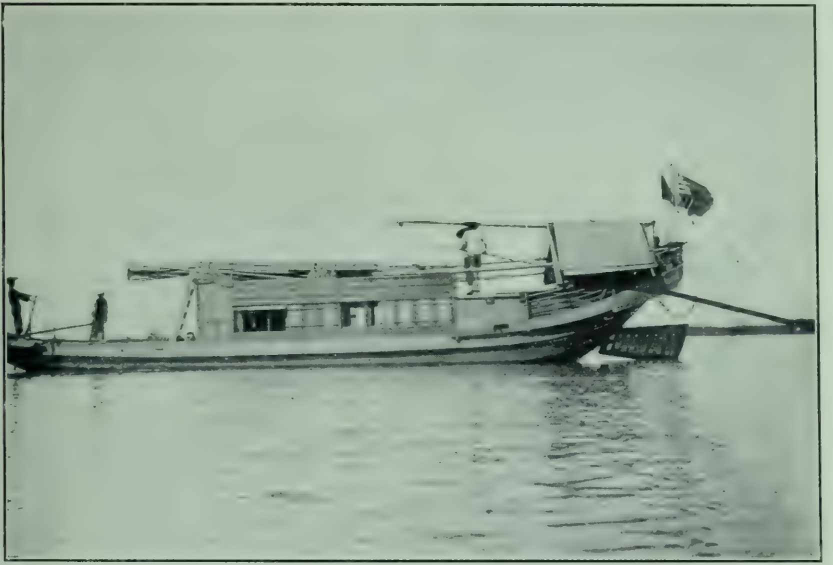
A LOCATING PARTY ESTABLISHED IN HOUSEBOATS.

the successful prosecution of the work, and it needs but the reminder of the difficulties which beset the first telegraph company, which had concessions for the erection of their line through Fukien and the southern provinces, to recall the influence of the mandarins in ordaining the success or failure of the enterprise.

Before actual surveys were commenced in Kwang Tung it was necessary to obtain the official sanction and approval of the Viceroy to proceed with this work. This official action, after the customary Oriental delay, appeared in the form of a proclamation, setting forth the good intentions of the foreigners in constructing a railroad which would confer untold benefits upon the Empire and its inhabitants, admonishing the natives to restrain from opposition to the work, and urging them to render all possible assistance to the engineers. Copies of this proclamation were posted throughout the villages adjacent to the projected railroad. A copy was painted on a large board frame and carried in advance of the surveying party, so that the natives along the line of survey could be fully informed as to the nature of the work and the proper authority for allowing the foreigners to proceed without molestation.

In the surveys for the Canton-Hankow Railway, the engineers were, in the main, Americans, with the assistance of a few Chinese and several Japanese engineers. The minor positions in the field parties, such as chainman and rodman, were quickly filled by Chinese who soon satisfactorily learned their duties. Concerning the efficiency of these Oriental engineers, not much that is laudatory could be said of the Japanese, and much less of the Chinese engineers who were educated in the technical colleges of North China. The Oriental engineers who were educated in America ranked well in ability, and it would seem that the Chinese, with proclivities for technical study and with a training in efficient engineering colleges, would make successful, competent engineers, who could in time carry on the management and the construction of the public improvements which might be commenced by foreigners.

The country throughout Kwang Tung is so intersected by waterways that the field parties, during both the surveys and the construction, usually lived in houseboats, which as the work progressed could be moved along the various streams to a locality adjacent to the line. The houseboats proved to be most satisfactory, since they afforded dry, sanitary habitations, isolated from the crowds of the curious, and separated from the vicinity of the filth and contagion of the village houses. These commodious boats provided room for the transportation of personal effects, and of field and office equipment which could not have been taken if the field party had been compelled to transport its belongings overland from camp to camp. Houseboats have



THE HOUSEBOAT OF A LOCATING ENGINEER.

TEMPLES, TYPIFYING THE RESIDENCES USED BY THE ENGINEERS OF THE RAILWAY SURVEY.

been utilized for the head-quarters of the surveying parties for a hundred and thirty miles into the interior, excepting for a distance of thirty miles across the divide from the Pearl to the North River.

When working in the interior, remote from the streams, the field party made its head-quarters in some temple which was rented for a nominal figure from the village elders. This structure has not the sacredness which we usually associate with the name "temple," and a more appropriate designation might be ascribed to the edifice by calling it a town hall. In these Chinese villages where no hotels or lodging houses exist, some building must be set aside for the use of visiting officials or strangers; it is therefore the custom to place these temples at the disposal of the visitor, who works, cooks, eats, sleeps within the sacred walls, without the slightest offence to the gods or the ancestors who were commemorated by that edifice.

In the matter of subsistence, the foreign engineers lived in the manner customary to western civilization. No difficulty was experienced in fitting out the field parties with native cooks, who had been taught western cooking either in the foreign concessions or in foreign countries, or in the warships of the foreign nations in the Oriental waters. The Chinese markets provided fresh meats and fresh vegetables, but in the interior canned goods were largely used. On account of the methods of Chinese garden cultivation, no vegetables were eaten uncooked, even though the native gardeners raised in profusion all delicacies of both the western and eastern worlds. No water was drunk unboiled or unfiltered. The Chinese servants could not be trusted to prepare the drinking water, excepting directly under the visual supervision of the chiefs of parties or a member of the medical corps. The extreme care taken with the drinking water kept the water diseases at a low percentage. The general health of the corps

SHIFTING CAMP IN THE INTERIOR.

in this humid tropical climate was excellent, but this was largely due to the thoroughly efficient medical staff which forms such an important department in enterprises operating beyond the pale of civilization.

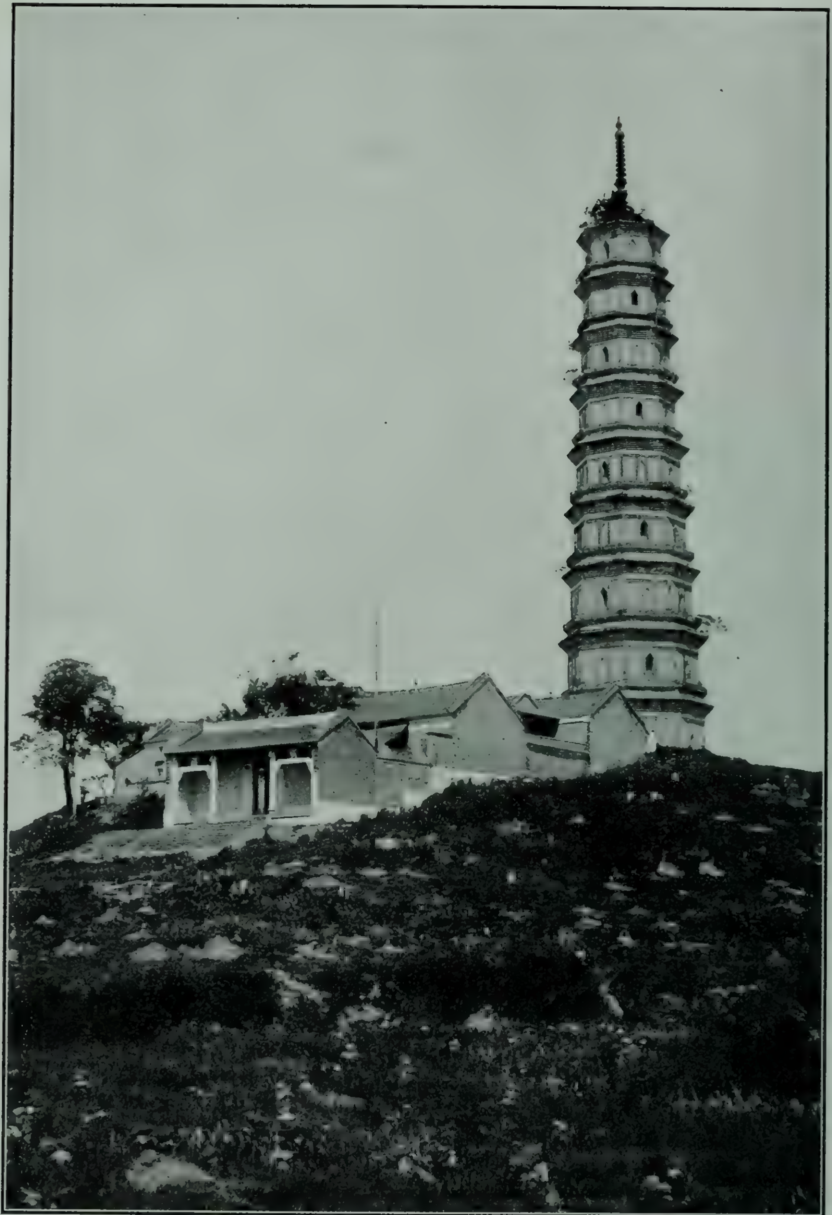
In the concession from the Chinese Government there was a provision which guaranteed the protection of the lives and property of the foreigners engaged in this railway enterprise. Authority was given to the railroad company to enlist regiments of native soldiers to serve as railway guards. In addition to these guards, other soldiers when needed were furnished by the viceroys of the provinces or the magistrates of the districts in which the work was being done. The use of soldiers with the surveying parties was twofold; the one purpose was that of protection, the other was that of display. As a matter of protection, the numerous instances of disturbances and riots proved the Chinese soldiers wanting in the qualities which we usually ascribe to military men. Considering the methods of recruiting these regiments one cannot expect much from the ordinary Chinese soldier. He is usually a low-grade coolie, inefficient as either a laborer or a thief; he is placed in a uniform marked on the breast and on the back with the inscription denoting the province, district, or company to which he is attached; he is poorly armed with a gun or a revolver badly copied from some European model. There does not seem to be any obligation or penalty in the enlistment, so that when the conditions have become

INSPECTION OF THE VICEROY'S SOLDIERS AT WONG SHA.

CAPTAINS OF THE RAILWAY GUARD.

unsatisfactory, the soldier can leave the service by taking off his coat. The only inducements which cause him to remain faithful are his monthly salary and his freedom from work.

Just previous to the beginning of the surveys in any locality, the locating engineer, together with the interpreters, mandarins, and escort of soldiers, makes a formal call upon the magistrate of the town or district in which the surveys are to be made. The official call not only gives the surveying project the stamp of official approval, but being in keeping with the strict Chinese etiquette it often serves to



A TYPICAL CHINESE HILLSIDE, THICKLY SET WITH GRAVES.

The graves are marked by fluttering strips of paper, held down by clods of earth. Once a year, in the spring, these strips are renewed by visiting friends, with the setting off of firecrackers and other ceremonies.

obtain the good will of the officials and prevents the secret inciting of opposition. It has always been necessary to pay the greatest respect to the officials and elders of the various villages along the line, and wherever it has been possible to obtain their good will, the difficulties of the work have been greatly diminished. The field parties are accompanied by mandarins of a low rank who are thoroughly conversant with the nature and needs of the railroad work, and who can take charge of the soldiers and affairs outside of engineering, such as adjusting the payments for crops or trees which might have been destroyed in making the surveys. The efficiency of these accompanying mandarins is a controlling element in the success of the field party.

Taken as a whole, there has not been great opposition by the natives to this railroad work. Riots and disturbances have arisen at times which were aimed against the surveys or the construction. The enmity of the great mass of Chinese to the introduction of any method of accomplishing results differently from their ancestors has caused the ignorant and the superstitious occasionally to offer armed opposition to the progress of the work. The engineering corps has been fortunate in these affairs so that no serious results have occurred. Prompt and sincere assistance on the part of the Chinese officials can always convince the rioting populace of the error of their actions and their misdirected efforts in the destruction of the "foreign devils."

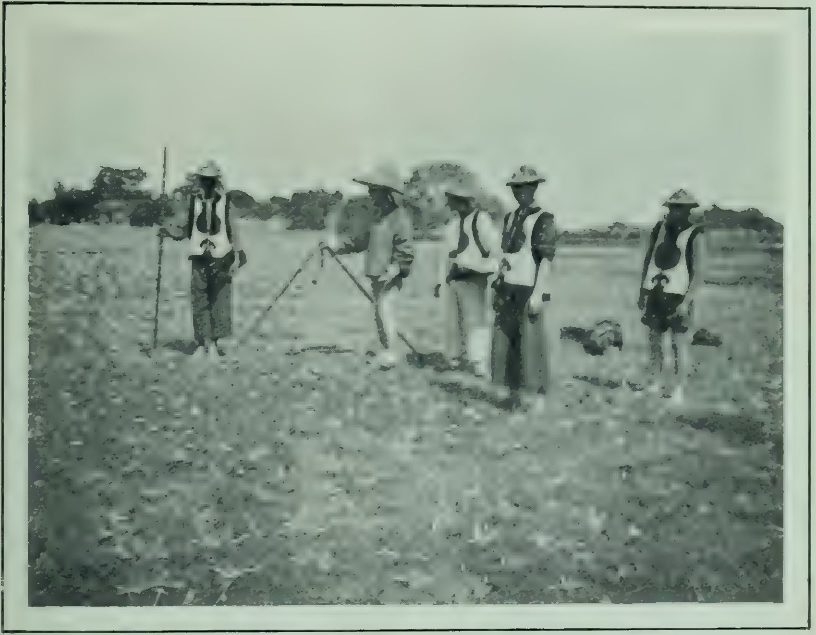
When the locating engineer selected his line, it was the general practice to please the natives so far as possible and yet lay down a road economical in future construction and operation. The natives would request the avoidance of the proximity of the line to villages, to graves, to temples, to certain trees or certain hills as the case may be. To the villager the location of the railroad near his home meant no increase of business, but only a loss of arable land. The destruction of the graves or temples meant probable future disaster to the community. Throughout Kwang Tung nearly every hill is utilized as a graveyard, and in the more populous districts it is impossible to project a suitable line which would not intersect these cemeteries. In passing through these hills, care was taken to avoid disturbing the more important graves as designated by sunken masonry monuments. Yet little trouble was finally experienced when it became absolutely necessary to excavate where the graves were located. It was merely a matter of paying the price, which after considerable haggling was generally reduced to a low figure.

One of the strongest features in opposition to the railway line was the cutting through certain hills which had been held in sacred awe by the villagers. It was only with the greatest reluctance that the villagers would allow these hills to be cut, and in fact, in some cases, it was necessary to shift the line in order to appease these superstitious beliefs. This opposition is due to the peculiar superstition of the Chinese concerning "Fung-Shui" (literally, wind and water; liberally, the gods of wind and water.) The superstitious belief in the power of the "gods of wind and water," more than any thing else, has prevented the opening up of mines throughout southern China where the country is so rich in mineral wealth.

Considerable trouble was experienced in preserving the stakes which were placed on the surveyed line. For many months, different methods of threats and entreaties were employed to compel the natives to leave the stakes where the engineers had placed them; but wood is too valuable in China to be left around loose, and so the stakes gradually disappeared. It finally became the practice of the locating parties to make the surveys as free as possible of any stakes remaining in the ground after the advance of the survey. The important transit points were well referenced to natural objects, and the stakes marking these points were deeply buried so that at a future date when construction began, these buried stakes could be relocated and the necessary intermediate stakes placed by the resident engineer.

After the location surveys had been completed, the next step toward construction was the right-of-way surveys and the purchasing of lands. These surveys, with the field work and drafting, proved more expensive than those of reconnoisance and location. The farms of the Chinese are very small, the separate rice fields much resembling our garden plots. The property lines run in all directions, yet it was necessary for the field party to stake out each plot so as to designate accurately the land to be purchased for the railroad. The Chinese land owners have been particular to mark their various fields, and a hasty glance at the numerous inscribed granite monuments protruding above the surface of the ground would lead one to suppose that the land was carefully laid out and defined. As a matter of fact, these stones are placed not on the corners or on the side lines of the field, but approximately in the centre, with no reference whatever to the limitation of the area. Usually the distinction between owners was made by a small dike, but yet many fields belonged to many separate owners without the slightest mark designating the dividing line of the different farms, so that the proper boundaries became matters of arbitration among the land owner, his village elders, and the railroad deputy mandarin accompanying the party to adjust such affairs.

When the property maps were completed, they contained the names of the owners, the numbers of lots, and the areas of the ground, in Chinese characters, so that the property owners and the Chinese Railway Land Department could understand the map without the aid of an interpreter. The Chinese unit of land, called in Cantonese a "mou," contains six-thousand square Chinese feet. Unfortunately, the length of a Chinese foot varies throughout the Empire, so that the area of a mou is considerably different in the various provinces of China; in Canton, the unit area so closely approximated a fifth of an English acre that this ratio was chosen for converting the acres into Chinese measure.



A CHINESE SURVEYOR, WITH HIS INSTRUMENTS AND PARTY, IN THE FIELD.
The attendant on the left, with the rod, carries the abacus. The surveyor holds the large dividers—the sole measuring instrument—with which the lines are stepped off.

For the actual transactions in the purchasing of lands and the clerical work on the deeds, the Railway Company established a land department in which Chinese officials had entire control, excepting that the engineer in charge of the work conferred with the purchasing mandarin regarding the unit price paid for land. This would prevent any unscrupulous officials from advancing the price beyond a reasonable figure, although ultimately the Imperial Government would pay for all lands purchased.

Before proceeding with the purchase of lands, it was necessary to employ Chinese surveyors to demonstrate to the land owners that no error in measurement had been made by the foreigners. These native surveyors, with the right-of-way maps of the railway engineers, would locate the various plots of ground and mark out the exterior by stretching a string around the boundaries of the lots to be measured. Then taking large wooden dividers between whose point were exactly five Chinese feet, the surveyor proceeded to step this spacer around the exterior of the plot. This measuring was done in a rapid manner, the result carefully tabulated in field books, and the areas immediately calculated upon the abacus. It was never thoroughly understood by us engineers how the Chinese so quickly measured and computed these areas, since it had taken the foreign engineers days to perform the same work done by Chinese in hours. It is interesting to add that the Chinese always checked the maps exactly.

Contrary to expectations, the land owners allowed the railroad construction to be begun in their fields not only before the land was paid for, but before the price was agreed upon. The natives seemed to have faith in the fairness of the Chinese officials in charge of the Land Department, and in the foreign engineers, that a just price would be paid for the land. This allowed the commencement of the work sooner than anticipated, but it had the disadvantage of allowing the procrastinating Chinese to dally with the land purchases so as finally to exasperate even the limit of Chinese patience and cause trouble on the main line in the following year.

STORES ARRANGEMENT AS A FACTOR IN SHOP MANAGEMENT.

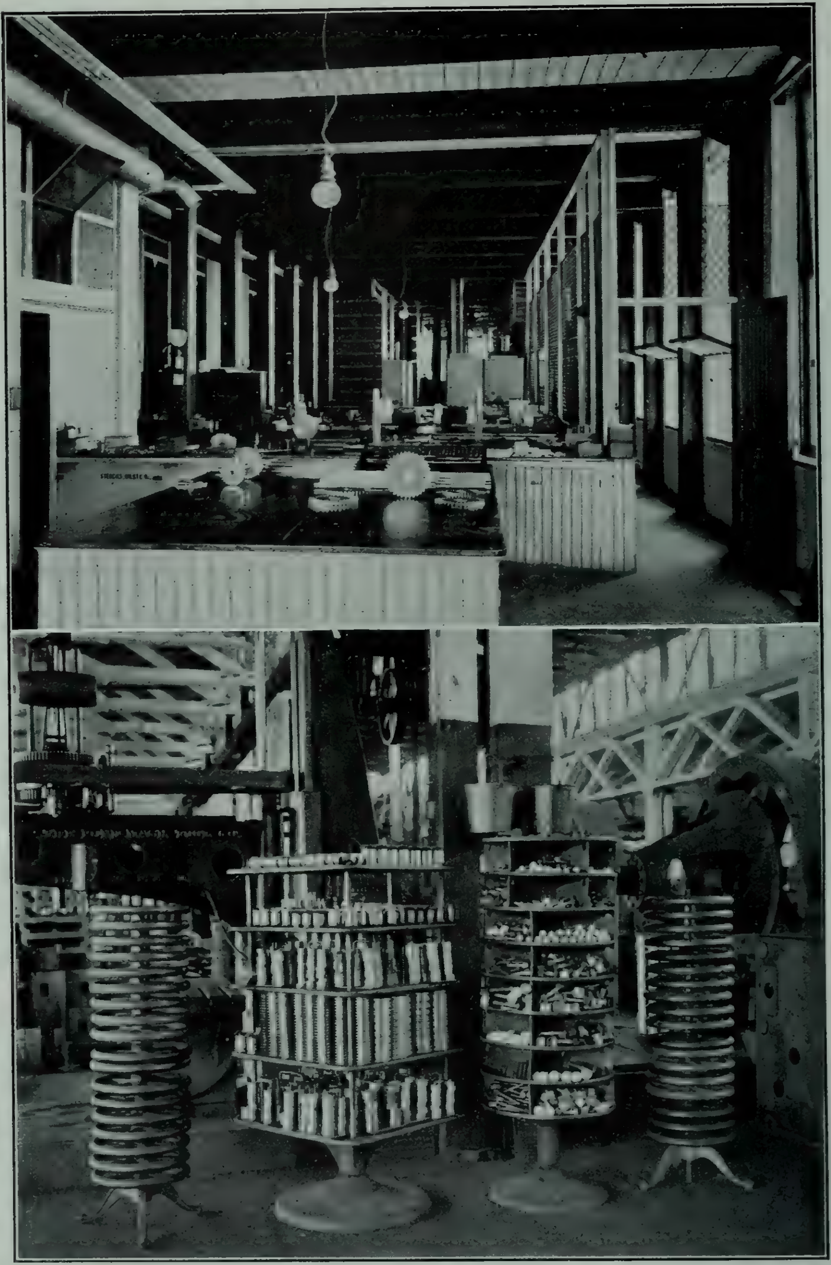
By John Ashford.

II.—The Details of a System Carried Out.

In introducing Mr. Ashford's first article, in our preceding issue, we referred to the interest which the discussion of stores-room practice carries, by virtue of the relative backwardness of this department in many otherwise well organised shops. This interest appears so keen, on further pursuit of the theme, that we have arranged to follow Mr. Ashford's exposition in this number of a definite system, by a series of papers, describing in detail and with full illustration the methods of some of the foremost and most modernised shops.—THE EDITORS.

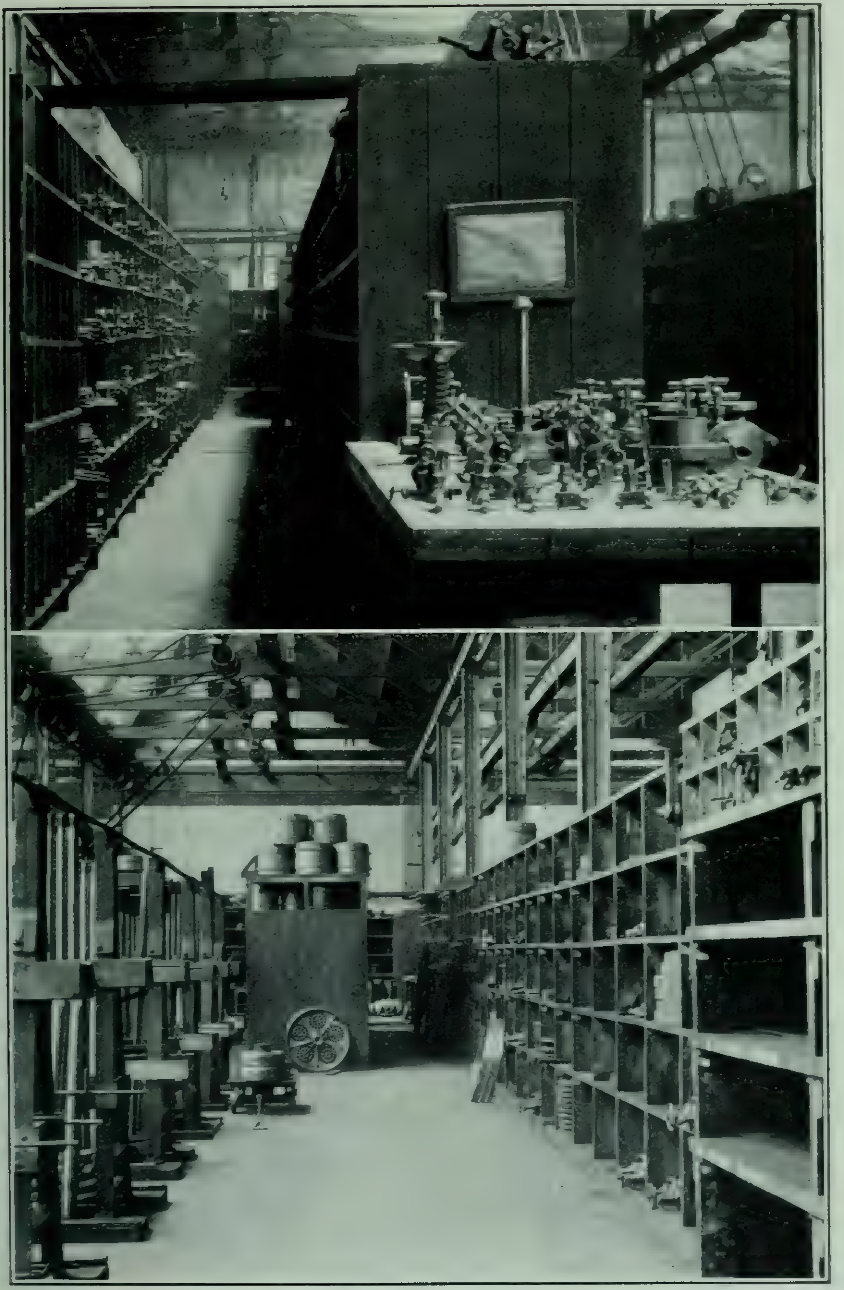
THERE are of course various ways of ordering work from the shops; in some places each detail is ordered, and in others the orders are very broad, much being left for the men to find out afterwards from the drawings or by enquiry. In some factories the card system of ordering and costing is worked with great ease, while in others all orders are written on sheets and costing is independently looked after.

In any arrangement of ordering and costing there are four things to be observed—firstly, it must occasion as little interruption to work and delay in the shops as possible; secondly, it must work smoothly; thirdly, it must give accurate results, and fourthly, it must not be clumsy or costly in itself. Of these four things that should be observed the first and fourth are often wrongly valued. A system may be called cheap because it takes few clerks to work it, and yet it may be very expensive in delays to the men in the works, whereas another, using more clerks, and appearing to be more costly, is yet the cheaper in reality. It must be remembered that the men must get particulars of their work from some source, and it is decidedly cheaper for it to go to them than for them to fetch it or seek it. Further, time has to be booked for cost-keeping purposes, and it is a costly matter for the workmen to do it all themselves. The men are generally slow at clerical work—at any rate, much slower than a clerk, and they individually would take at least twice as long as a clerk to do a given amount of writing. Their rate of wages, moreover, is generally much greater than the clerks'; thus all writing done by a mechanic will cost the firm about four times as much as if done by a clerk. Writing has usually



STORES ARRANGEMENTS IN SOME OF THE WORKS OF THE NILES-BEMENT-POND COMPANY.

Above is the shipping and stores room of the Pratt & Whitney Works. All tools, after final inspection, are delivered to this room and prepared here for shipment. Below is a section of the stores department in the Pond Works; the racks for holding various parts of machines are fitted with ball bearings, so that any part desired may be easily obtained by turning the stand around. The system is very advantageous where space is limited.



SECTIONS OF THE STORES DEPARTMENT, MESSRS. G. & J. WEIR, LTD., CATHCART, GLASGOW.

The upper view shows the storage of finished material in the brass stores. The lower is the main finished-goods department. Upright racks for pump rods are seen on the left; pigeon holes for valves, springs, covers, etc., are shown on the right and at the rear.

to be done in several directions, i. e., the writing of orders by the order department, the writing of contracts by the piece-work or premium clerks, the booking of the men's time for each operation, and, where books are used for costing, the posting of items from time sheets to cost books. Thus if a job has five operations upon it, before it is finished it will be referred to in writing no less than eight or nine times, of which five will be by mechanics if the men book their own time on sheets. Let us consider now a method of fusing these various writings together with a view to reducing the total of it and giving all information directly to the man who needs it. From the specification upon which the draughtsman has put the drawing numbers, the order department would prepare a series of order cards, one for each item not in stock that must be manufactured. These order cards would be numbered in sequence, and when written their numbers are entered in the order card number column on the specification of details. This is to tell the cost office what order cards have been issued. The arrangement of these cards will vary according to the factory where they are used, but may be like the illustration on the opposite page.

On the front of the card is its own number, the identification number or symbol, and blank places for filling in other information. The reverse has a list of machining operations with space for cash and process-card numbers. The order cards are first passed to the works office, which is immediately associated with the works manager and is the place where machining processes, tools, and other works matters are arranged, there to have tick marks placed against the processes the articles must undergo; the cards are then returned to the order clerk. He then prepares a process card for each process the work must undergo, and this process card will serve the purpose of shop order, contract for piece-work, identification note to inspectors and stores keeper, and finally as time card to supply information to the cost office.

A process card used in conjunction with Rochester recorders is illustrated on page 183.

The card will be seen to give particulars of the work, the process it is for, the drawing number, and identification symbol, on one face; upon the other there is space for the man's name and number (which is filled in by the foreman), order-card number for posting purposes when it reaches the cost office, and a place for the inspector's initials. The card will thus be seen to contain all information the man needs to identify the work and secure the correct drawing. To facilitate identification, the schedule number or symbol explained last month can be used as a pattern number, which should be clearly impressed in the

PRIME COST

Process	Process Card No.	£	s	d
Material				
Forging				
Turning				
Boring				
Planing				
Shaping				
Slotting				
Milling				
Drilling				
Slot Drilling				
Grinding				
Dressing				
Fitting				
Foundry				
Patterns				
BLANK & Co. YORK	Total			
	Cost per Article			

REVERSE OF THE ORDER TICKET.

Identification No.______________ **Order Card No.** 44253

Machine or Stock No.______________ **Progressive Order No.**_______

Description________________________

Material__________ **Drawing No.**__________ **Pattern No.**

Weight in the Rough: tons____ cwt.____ qr.____ lbs.

Inspected to certify quantity and finish by__________ **Received into Stores and Number found correct** by__________

ISSUED TO MACHINES

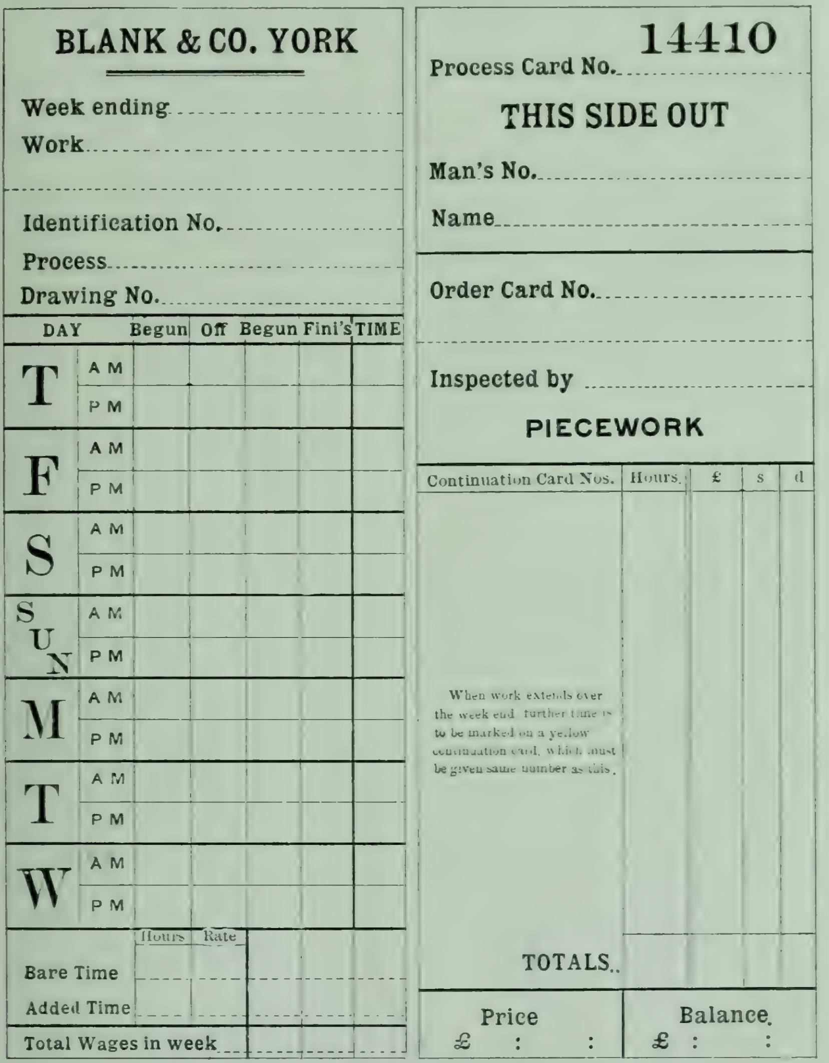
Date	Machine No.	Quantity	Date	Machine No.	Quantity

ORDER TICKET, REPRESENTING A LINE OF THE SPECIFICATION OR SCHEDULE OF PARTS. AS SHOWN ON PAGE 99 OF THE ENGINEERING MAGAZINE FOR OCTOBER, 1904.

The original is a white card, 4 by 6 inches in size. This is written out in the order office, submitted to the works office, and then sent to the stores department. The stores keeper gets the raw material for it and holds the card until the work is done, when he affixes his initials and sends it to the cost office. The cost keeper, after posting from the process card onto the order card, posts its total in turn to the specification sheet received from the order office.

FEATURES OF THE STORES DEPARTMENT CONDUCTED AS A CONTROL DEPARTMENT IN THE WORKS OF MESSRS. ALFRED HERBERT, LTD., COVENTRY, ENGLAND.

The upper view shows that portion of the stores devoted to inspection and storage of parts of machines in progress of manufacture. The head stores keeper and chief inspector are one and the same person. Work is returned to the stores after each operation, to be checked by the drawings, gauged, and generally inspected. After inspection, parts are kept in the stores until wanted by the works, with the object of reducing the amount of "dead material" in the shop. The lower picture shows the stores for small parts, made to stock orders on automatic machines. Standard reference numbers are shown on the cards attached to the pigeon holes.



BLANK & CO. YORK

Week ending ....
Work ....

Identification No. ....
Process ....
Drawing No. ....

DAY		Begun	Off	Begun	Fini's	TIME
T	A M					
	P M					
F	A M					
	P M					
S	A M					
	P M					
SUN	A M					
	P M					
M	A M					
	P M					
T	A M					
	P M					
W	A M					
	P M					

	Hours	Rate			
Bare Time					
Added Time					
Total Wages in week					

Process Card No. 14410

THIS SIDE OUT

Man's No. ....
Name ....

Order Card No. ....

Inspected by ....

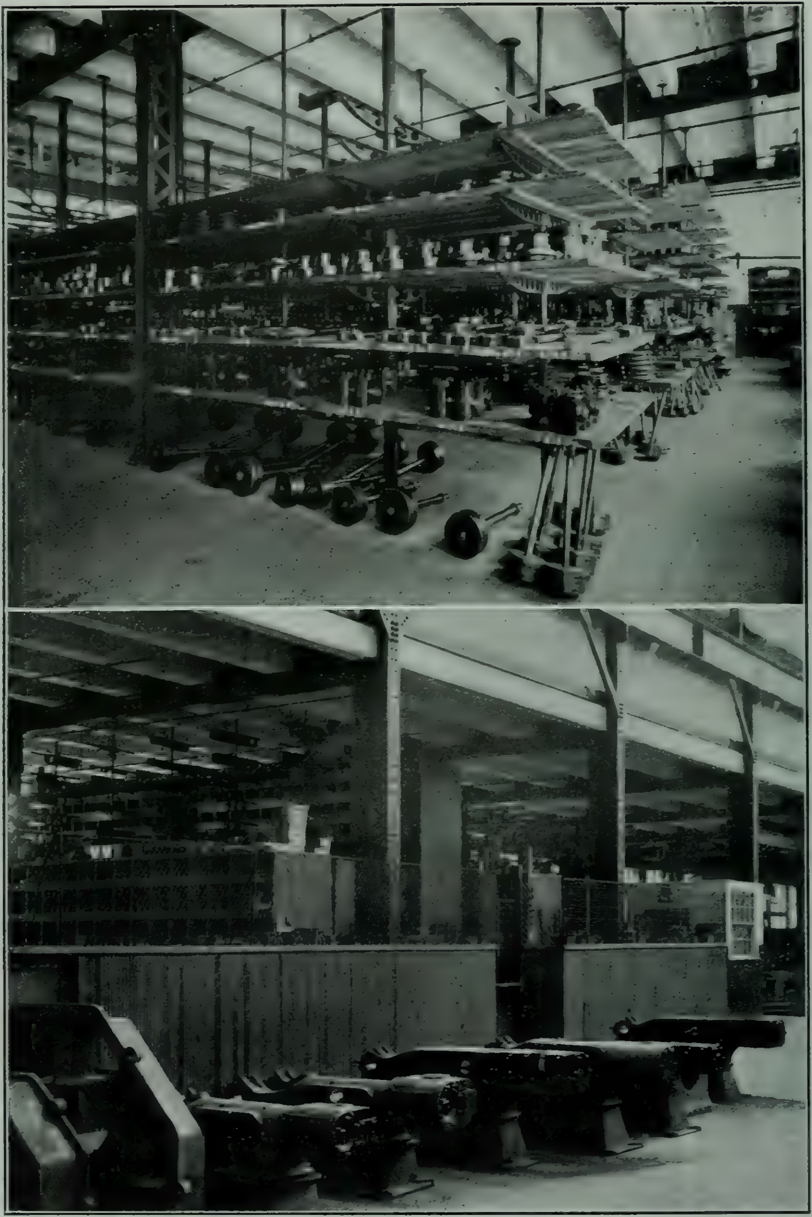
PIECEWORK

Continuation Card Nos.	Hours.	£	s	d
When work extends over the week end further time is to be marked on a yellow continuation card, which must be given same number as this.				
TOTALS..				

Price	Balance.
£ : :	£ : :

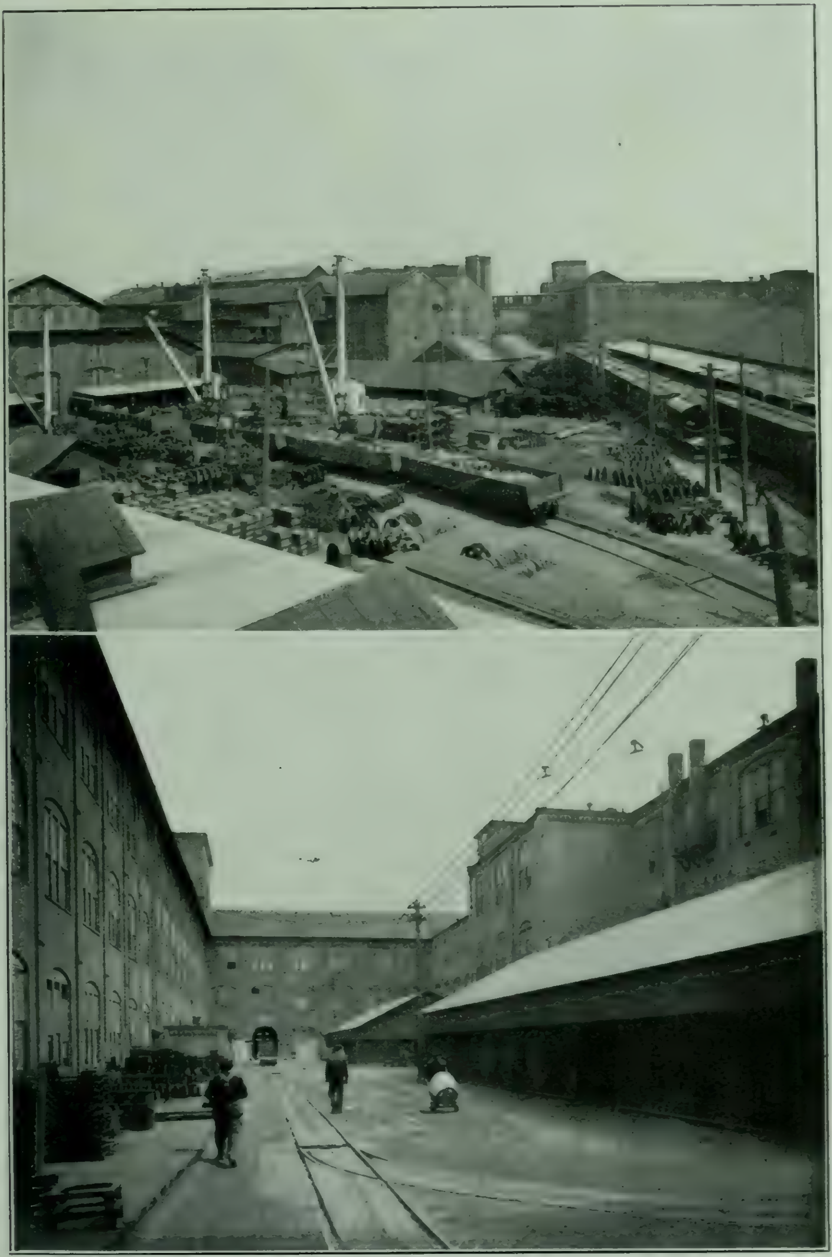
FRONT AND REVERSE SIDES OF THE PROCESS TICKET.
The original is a green card, 7 by 2¾ inches. This conveys all information to the men as an order, and serves as a contract for piece work, and as a time card. After passing to the stores department with work for inspection, it is noted as "in" on the order card. It then goes to be made up as a contract for payment of balance due the workman, and finally reaches the cost office where the money it represents is posted to the order card when the latter has also come in. It is used in conjunction with the Rochester Recorder.

casting in a place where it will not be tooled off; thus the man can tell at a glance which castings or forgings (the symbol should be stamped on forgings before they leave the smithy, or at least be



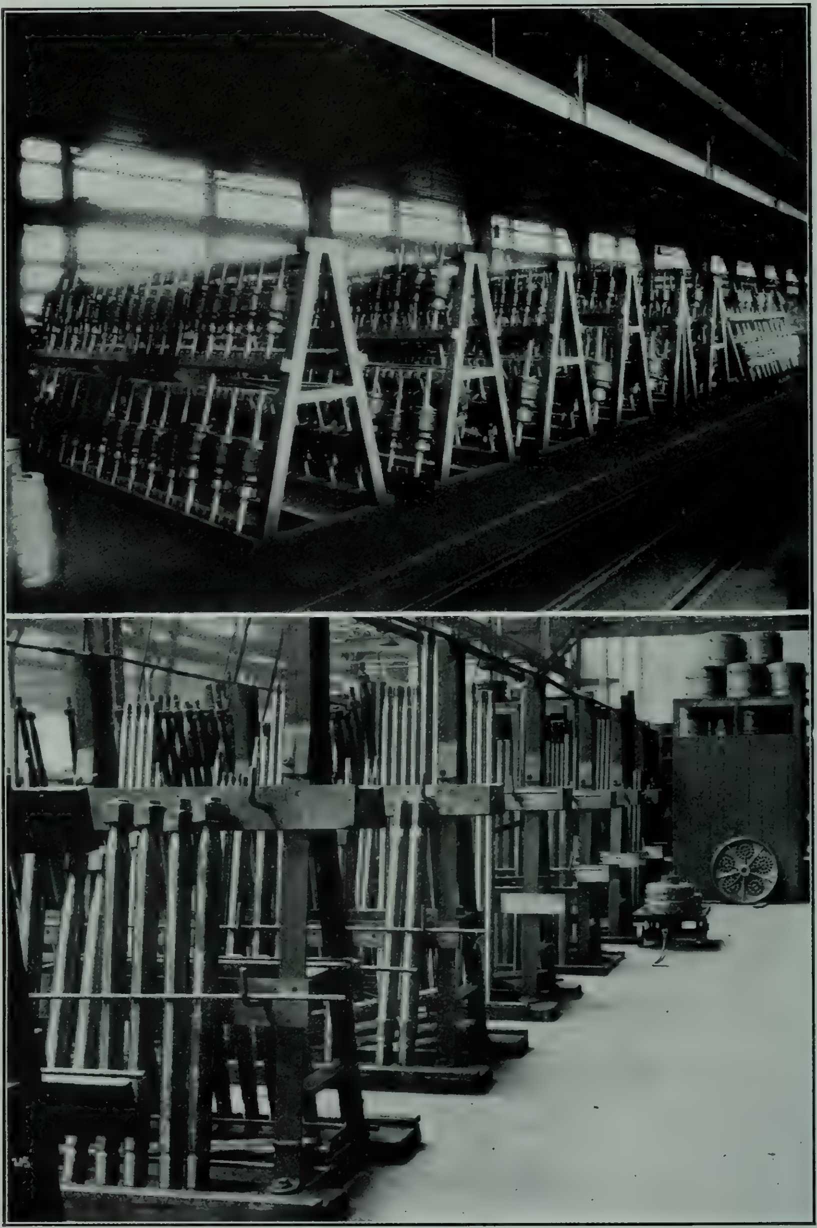
STOCK-ROOM FEATURES IN THE NEW WORKS OF THE B. F. STURTEVANT CO., HYDE PARK, MASS.

The stock room, 40 by 120 feet, is on the ground floor at the junction of the machine and erecting departments. The lower view shows the portion devoted to purchased material—bolts, nuts, etc.; metal trays were seriously considered but abandoned for the older wooden construction. The office of the chief clerk of the department is here. Delivery doors are recessed to be out of the line of overhead crane service. The other end of the room, seen above, is for storage of finished engine parts, the shelving and bracket arrangements being of original design adapted to the conditions. A brick-walled storage room in one corner is for storage of copper, tin, lead, etc., with elevator to the brass department above and chutes for chips therefrom.



YARD STORAGE IN THE SHOPS OF THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

The lower picture represents the storage yard for castings and sheds for half-finished material, adjacent to the buildings devoted to the manufacture of switchboards, switches, and supplies. The upper view is in the yard back of buildings 4, 6, 8, and 10, and shows the electric derrick cranes and electric switching locomotive.



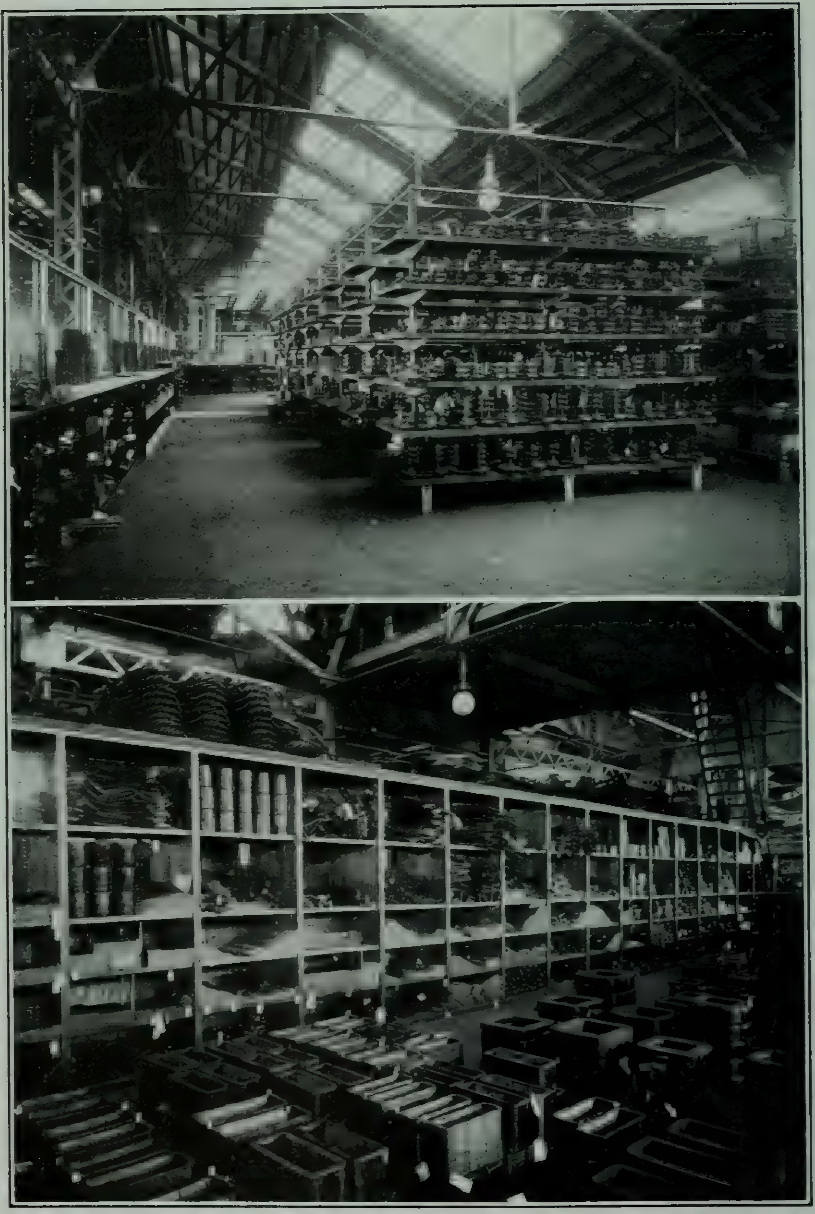
TWO EXAMPLES OF THE USE OF THE VERTICAL RACK SYSTEM IN THE STORES DEPARTMENT.

The upper one shows the method of storing armatures in the stores room of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The lower shows the finished rod store in the pump works of Messrs. G. & J. Weir, Ltd., Cathcart, Glasgow.

painted on,) are correct for his job. The procedure in handling these cards will now be as follows:

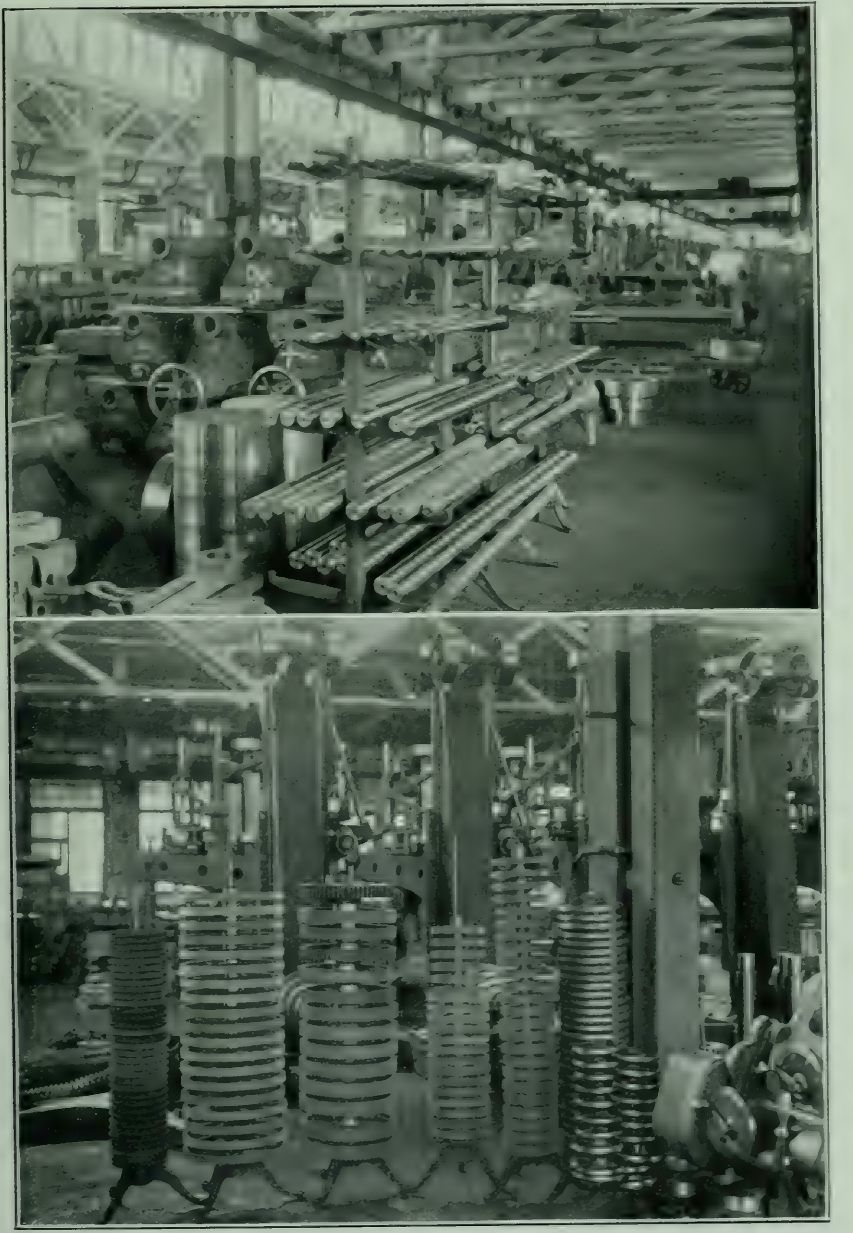
When written out by the order department (their preparation can be facilitated by the use of rubber stamps) they are handed to the piecework or premium clerk, who puts the prices or premium times upon them and passes them to the shop foreman. The latter sorts them over, assigning them to his men, who when starting the job have the cards clocked in the recorders to mark the time. They follow the usual recorder procedure until the work is done, when the inspector takes the card and (after satisfying himself that the work is correct) initials it in the space provided. The card then passes to the piecework department for the calculation of balance, if any, and from there to the wages clerk as voucher for the payment of balance. When the cards have fulfilled their function to this point they go to their final resting place—the cost office—for the cash amounts to be posted to the order card. The order card, when it first leaves the order department, would go the stores keeper to be filed by him under its consecutive number and held until the work is received in stores, actually or virtually, in a finished condition. Incidentally, when raw material is issued to the shops (the process ticket being shown to get it) the weight is booked on the order card to inform the cost office what material is used. When the last operation on a given piece of work is completed it is passed into stores by the inspector, who initials the order card to certify completion, and the stores keeper also initials the card to certify the receipt of the work and then passes the card to the cost office, to be completed and finally posted as cash to the item on the specification sheet with which the ordering started. The sheet thus sums up the information brought forward by the cards.

The frequent reference to the stores keeper shows him to be an important official through whose hands many things must pass in addition to mere articles for storage. He is aware of all work in progress through the shops, and he should know the position in which it stands. The inspectors and he should be in close touch, or better still the inspectors should be subject to his control; thus he would in reality be the head inspector. The initial specification or order sheet of which a copy is made for the cost office is in his hands, and upon it he indicates the progress of work by noting which operations are inspected. The whole of the rough material with castings and forgings would be under his control, so when his inspectors reject bad work he must see to it that fresh castings, etc., are not only in stock, but that re-orders



STORES PRACTICE IN THE SHOPS OF THE WESTINGHOUSE ELECTRIC & MFG. CO., EAST PITTSBURG, PA.

The upper view shows the system of storing brush holders and commutators; the lower, the storage of finished coils and insulations.



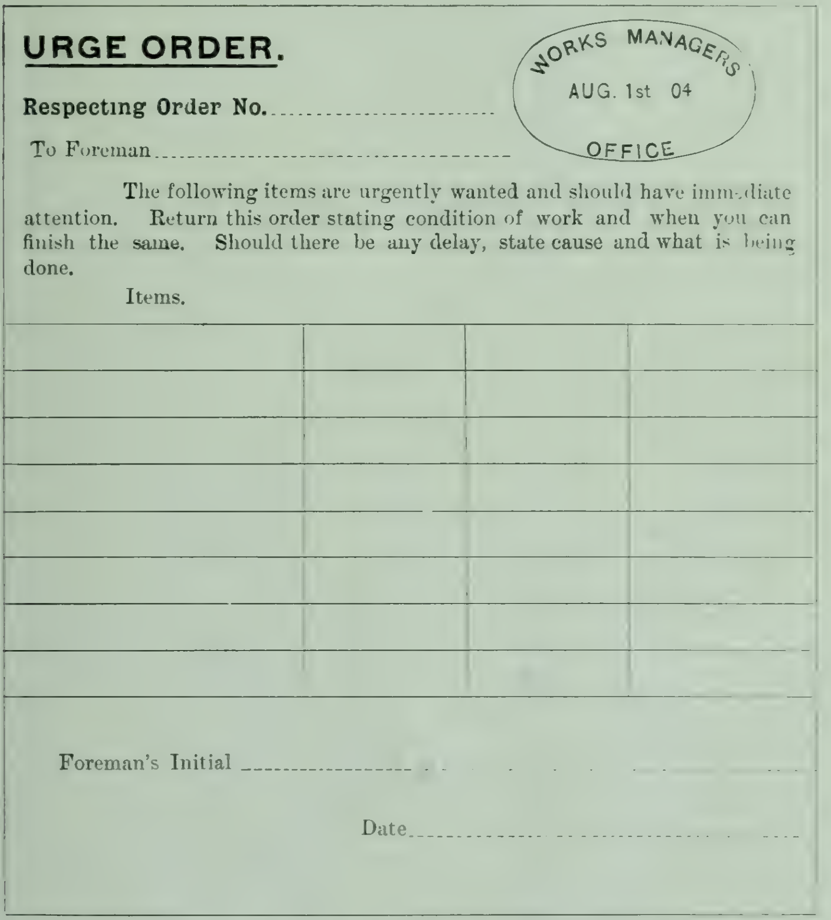
STORES ROOMS OF THE POND MACHINE TOOL WORKS, NILES-BEMENT-POND CO.

Above are seen the racks for holding bars, either in the rough or in various stages of completion. Below are the stands for holding rough castings, finished parts, or work partially completed.

STORES ARRANGEMENT IN THE WORKS OF THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., LTD., TRAFFORD PARK, ENGLAND.

The upper view is taken in the general stores room, the lower one in the motor stores.

are set in motion to put them through the shops. The works manager should give him dates by which the work should be finished, or progress reported upon, and if the work is not coming into stores smartly enough to keep to the dates he, the stores keeper, should write an "Urge Order" which he would hand to the manager, who is thus posted as to delays; and the manager then, after impressing his stamp upon it, would forward it to the foreman concerned. A form for such an urge order would be somewhat as follows:—



URGE ORDER.

Respecting Order No...............................

To Foreman..

WORKS MANAGERS
AUG. 1st 04
OFFICE

The following items are urgently wanted and should have immediate attention. Return this order stating condition of work and when you can finish the same. Should there be any delay, state cause and what is being done.

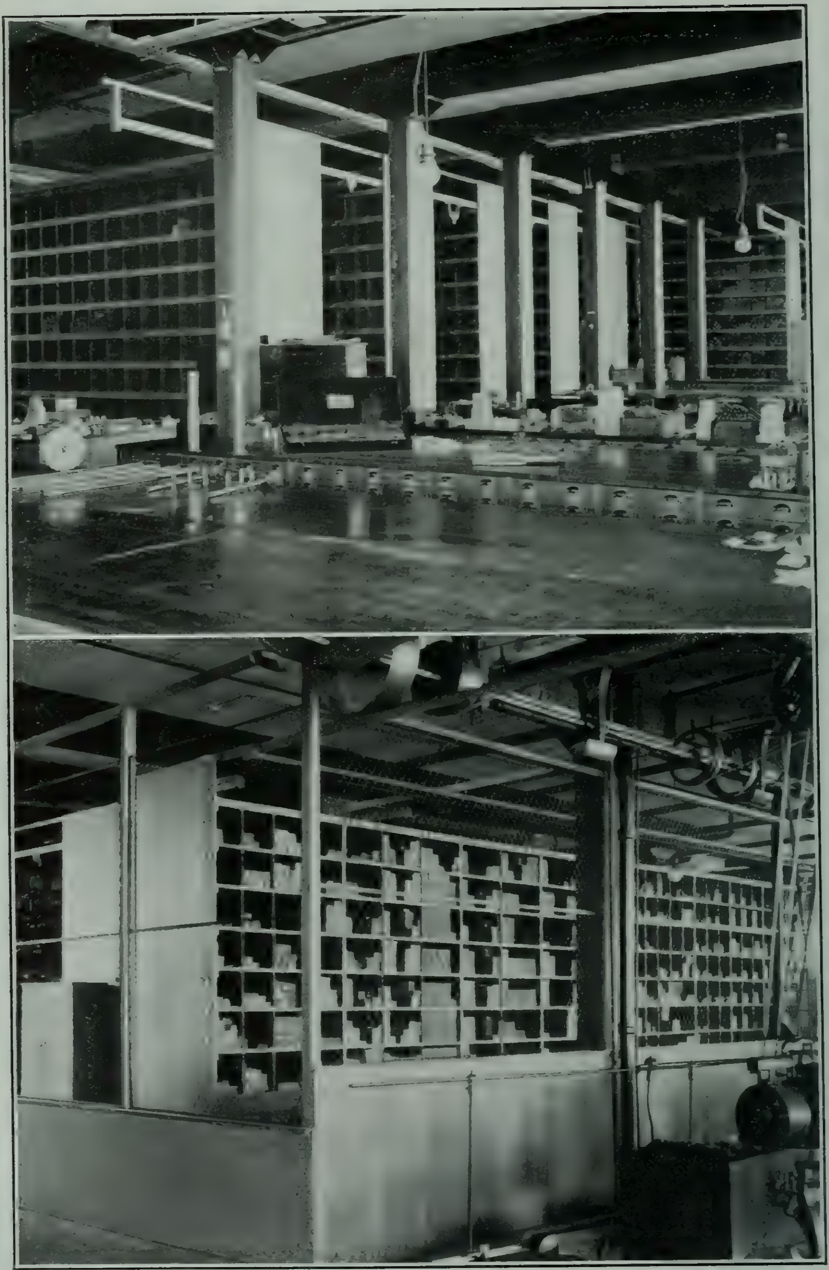
Items.

Foreman's Initial ______________________

Date______________________

URGE ORDER. FOR USE WHEN WORK IS NOT COMING THROUGH ON TIME.

Printed in red, on a white card 5¼ inches wide. This is to be filled out by the stores keeper and passed to the works manager for his observation, and for his information as to jobs that are falling behind. After he has put his stamp upon it he forwards it to the foreman with any special remarks.



THE STORES DEPARTMENT OF THE PRATT & WHITNEY CO., HARTFORD, CONN.

The upper view shows the tool racks, drawers for small taps, and benches on which orders are prepared for shipment. The lower picture gives a better view of the milling-cutter racks, etc.

THE STORES DEPARTMENT OF MESSRS. MELDRUM BROS., LTD., TIMBERLEY NEAR MANCHESTER, ENGLAND.

The upper view shows the stores room, looking from the stores keeper's office. The lower view is taken in the stores room, looking in the opposite direction. The office of the stores keeper is behind the glass partition in the background.

When work is received into stores, whether rough or finished, (and we may assume that the rough work is kept in a section of the stores, whether directly attached thereto or remote, still under the stores keeper) it must be booked in the stock book or upon stock cards.

Cards are much more flexible than books in such work as this, inasmuch as they can expand or contract in number as needed, and when kept in order they form their own index. On the other hand, the leaves of books cannot very well be extracted or inserted at will and the index must be a separate matter. The stock card would be like the following:—

STOCK CARD. **Identification No.**

Size of Article

Description of Article

Maximum Stock **Minimum Stock**

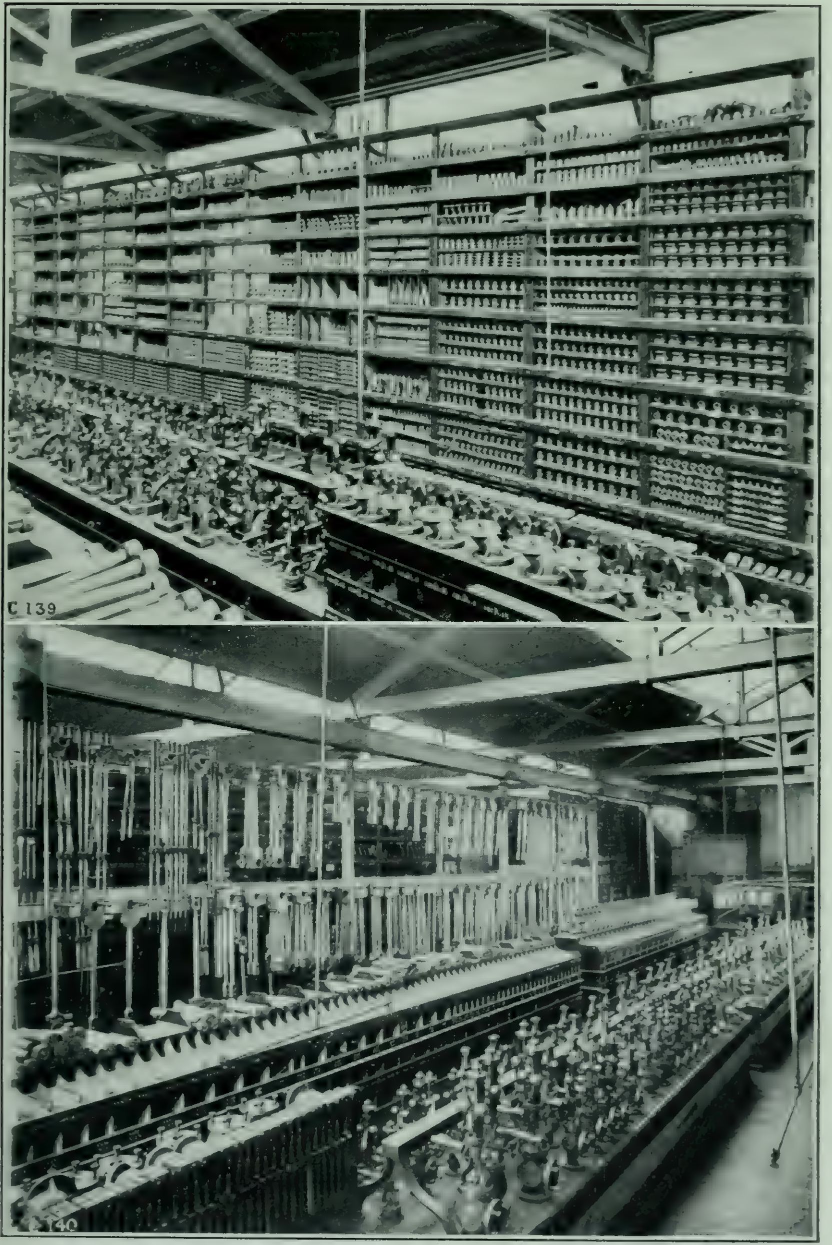
Weight of one article Rough

Weight of one article Finished

Remarks

STOCK CARD, FOR USE IN RECORDING THE QUANTITY AND LOCATION OF THE PARTS IN STORES.

The face of the card provides for identification, the maximum and minimum quantities to be stocked, and also provides space for rough and finished weights. These are useful for estimating purposes but are not necessary for stores work. Upon the reverse (page 196) provision is made for noting quantities, with dates, of articles received and issued from stores. It also provides space for the order number to which they are made—this latter information may prevent the issue of the parts for a wrong order—and it also assists in locating the work in stores; for, by numbering the pigeon holes, bins, or sections of floor space, they can be noted in the column headed "location." In this way the parts that may have been in store for quite a



INTERIOR OF THE STORES DEPARTMENT, MESSRS. MARSHALL, SONS & CO., LTD., BRITTANIA IRON WORKS, GAINSBOROUGH, ENGLAND.

long period for some reason can can be found as easily as the last arrivals, and there is no loss of time.

With parts that are standard stock and that are made to a stock order, it is necessary for returns of issues to particular orders to be sent to the cost office, and this can very well be done upon either a daily sheet or an issue card, which can be filed with the order cards.

RECEIVED INTO STORES.				ISSUED FROM STORES.			
Date	Quantity	Order No. made to	Location	Date	Quantity	Machine or Order No. issued for	Balance

REVERSE OF STOCK CARD. THE CARD IS WHITE, 4 BY 6 INCHES.

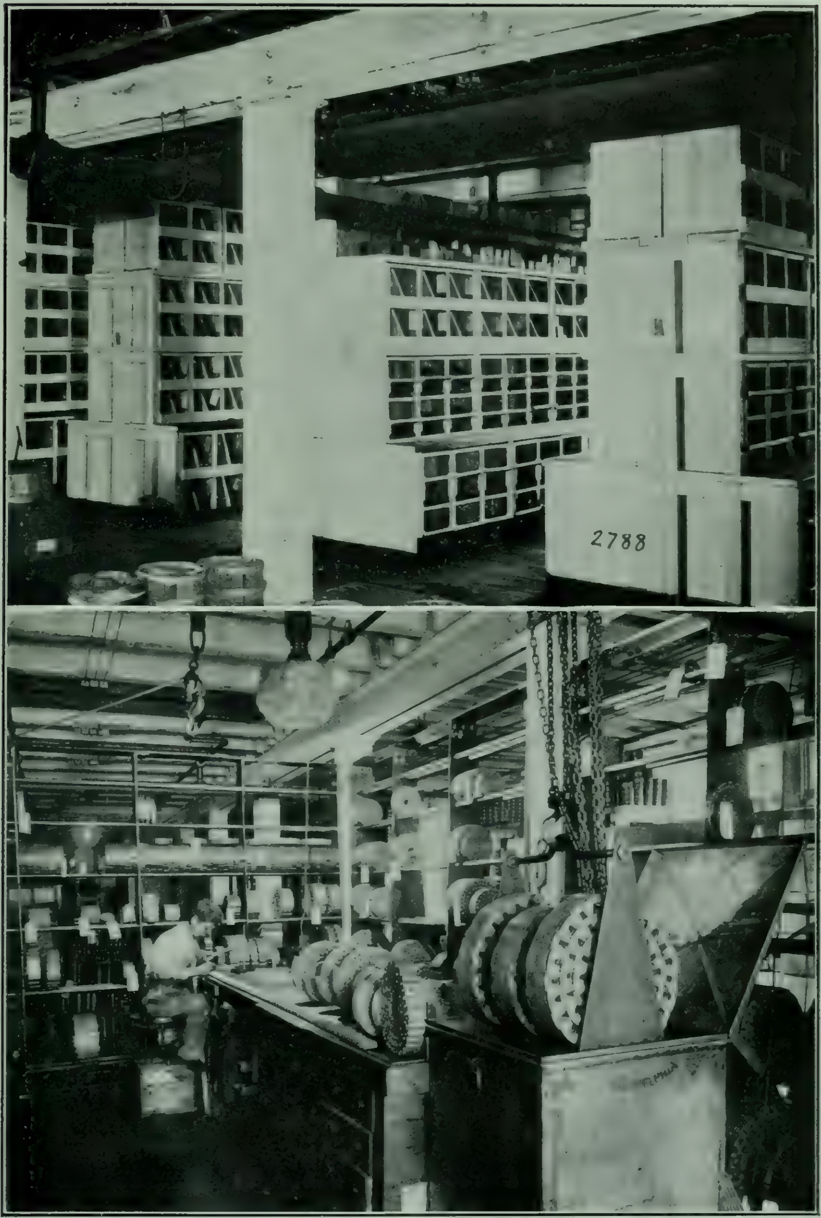
To sum up the working of such a system as a whole, in its effect on the operating of the before mentioned rapid-production machine tools and the general workshop economy:—

The system calls for the standardisation of detailed parts, itself an important matter.

It provides for the identification of parts by symbols, the same symbols serving as pattern numbers, so tending to ease and exactness of reference, and reduction in the labour of writing.

By the initial reference of orders to the stores keeper, it prevents the re-ordering of things already in stock and perhaps awaiting an opportunity to be used.

By the method of ordering, it conveys complete information to all concerned, the process cards carrying all particulars to the men; the cards also serve as piece-work or premium contracts, as time records, as balance vouchers, and as a record of progress. The various uses of the one card reduce clerical labour.



STORES-ROOM FEATURES IN THE SHOPS OF THE LINK BELT ENGINEERING CO., NICETOWN, PHILADELPHIA.

The upper view shows the bins for storage of bolts, nuts, rivets, etc. The racks are built solid, and the bins are in transferable units, shiftable at the convenience of the stores keeper. In the lower view is shown the section devoted to Renold silent chain. The tags, on which a correct balance of the contents of each section is carried, are plainly seen. The stores room is well equipped with industrial railways.

The time otherwise spent by the men in writing their time records, in finding out the order numbers and the drawing numbers, and in making other inquiries respecting the work, is saved at a cost of the time of the clerk who writes out the orders.

It provides for the maintenance in stock of all standard parts likely to be required, in such quantities as will avoid the running out of stock, and yet without inflation. By the inspection of all parts prior to acceptance in stores it secures the interchangeabilty of parts.

It preserves the continuity of the machine work by providing what may be called a "reservoir" of rough material in stores, and a receptacle for the finished work, with the certainty that the latter will be ready to hand when wanted.

It tends to reduction in assembling or erecting costs, by the systematic gathering together of finished parts ready to issue complete to the erectors, their time, which would otherwise be spent in looking up their work, being then turned to more useful account.

As the manager can obtain the state of progress of any work at any time, he is in a position to make safe promises to customers as to delivery.

It assists the foreman, inasmuch as it keeps him fully informed of all work coming forward and in hand for his machines and men; thus he can plan out his work beforehand.

The costs will be accurate, as the information sent forward is clear and definite and does not depend upon uncertain returns made by the men.

The stocking of standard parts provides for the prompt filling of repair orders, the quick fulfilment of which may often lead to good business.

The system places accurate information as to detail costs at the works-manager's command, so enabling him to make comparisons and to check excessive cost where it occurs.

Upon reading back, I feel that perhaps I have not represented with sufficient fullness the importance of the stores in such an organisation, although it may be perceived as an underlying thread throughout. The stores is, in fact, a virtual hub around which the work in progress systematically rotates until it is absorbed in detail and re-issued *en masse* to the assemblers or erectors, to be finished for despatch from the works; and when successfully operated it tends greatly to the smooth running and efficiency of the whole factory.

THE MINES AND MINERAL INDUSTRIES OF ITALY.

By Enrico Bignami.

A PRECEDING article* was devoted to the mining of zinc and of lead, which hold the first place among the metals in the mining industry of Italy. In the present article we shall give our attention to sulphur, which in value represents two-thirds of the entire mineral production of Italy, and which supports an industry with many interesting aspects.

In the volume recently published by the (Italian) department of agriculture, it is stated that the production of sulphur in the last official year (1902) amounted to 564,318 tons, of the value of 53,335,600 francs (average price per ton, 96.72 francs), while the total mineral production did not exceed 80,000,000 francs. Nine-tenths of the production of sulphur belongs to Sicily, where 510,432 tons were obtained, together with 3,329,370 tons of mineral matter, representing a yield of 15.27 per cent. The other one-tenth comes from the mining district of Bologna, from the sulphur pits of Romagna and the Marches.

Almost all the sulphur obtained in Sicily is exported—three-eighths to the United States, one-eighth to France, and the rest to the other countries of Europe, especially to Germany; 44,000 tons is exported to the mainland of Italy—a considerable diminution from former years, for in 1900 the number was 95,000 tons, and in 1901, 70,000.

As is well-known, sulphur is a mineral of the first class—that is to say a metalloid; it occurs either amorphous, or crystallized in two different forms, as octahedrons or as oblique prisms, always with rhomboidal base. It has a vitreous structure, is fragile, and not very hard. Its color varies from clear yellow to brownish yellow. Its lustre is vitreous; it is tasteless and odorless, but if it is rubbed or struck, it has a strong characteristic odor. It burns readily with a blue flame and produces sulphurous acid. It melts at 114 degrees C., and becomes transparent; at 160 degrees it loses its transparence, and also becomes viscous; at 260 degrees it liquefies again completely; and at 460 degrees it boils.

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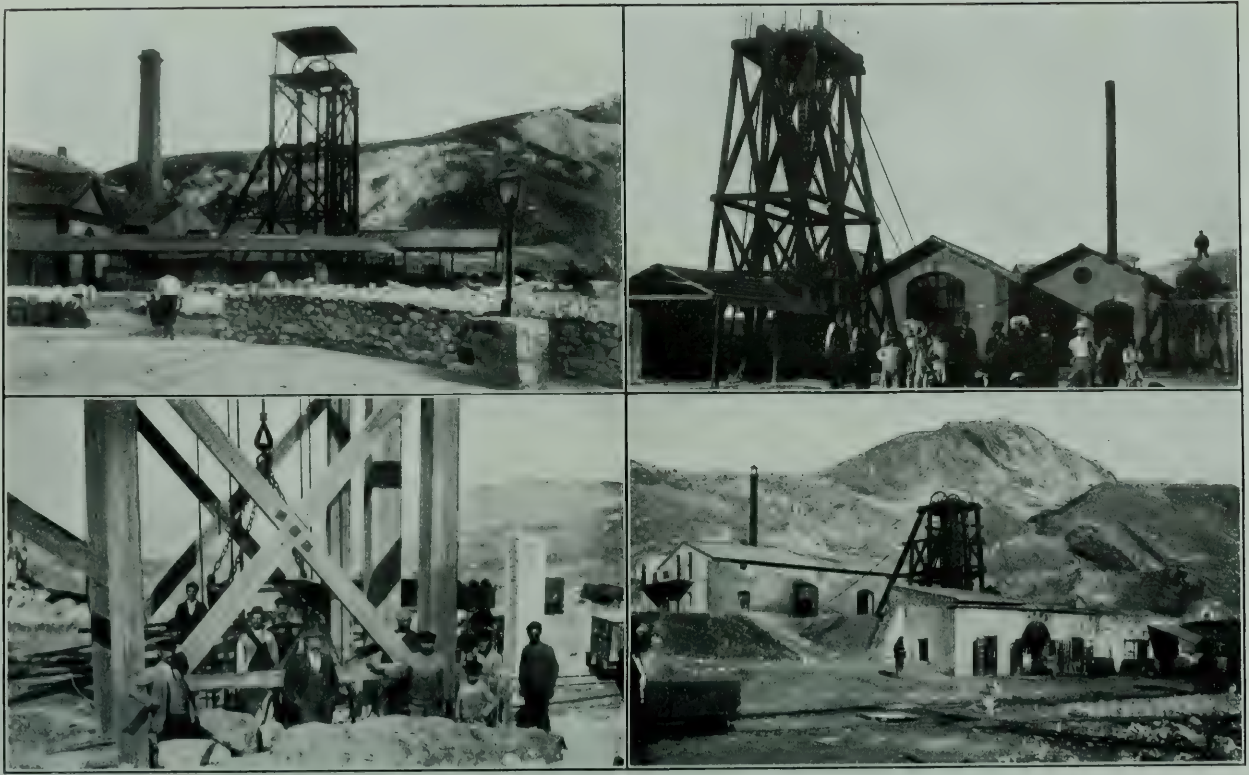
* THE ENGINEERING MAGAZINE, September, 1904.



TYPICAL SICILIAN SULPHUR MINES

At the top on the left, the Lucia; next to it on the right, the Gessolundo Manrelli, with a group of students from the Caltanisetta mining school. Below, on the left, the St. Jean shaft of the Quattrofiniate mine; on the right, No. 1 shaft of the Bosco mine, S. Cataldo.

The sulphur occurs free at the surface (pages 201, 202), or in mines, or sublimed in the volcanic regions called "solfataras," or combined with other minerals. The industry of sulphur production consists in the extraction of that substance from the earth, its separation from foreign substances with which it is mixed, and its transportation to markets.

AN EXPOSED SURFACE OF THE SULPHUR-BEARING LIMESTONE, AT CALTANISSETTA.

The industry has great importance in the national economy—very great indeed in the regions where it is especially carried on, as in Sicily and Romagna. In the economy of the nation, it represents, as already said, a value of 50,000,000 francs, and the labor of 50,000 workers—that is to say, the subsistence of nearly 25,000 families, or about 100,000 persons, who derive their living from it.

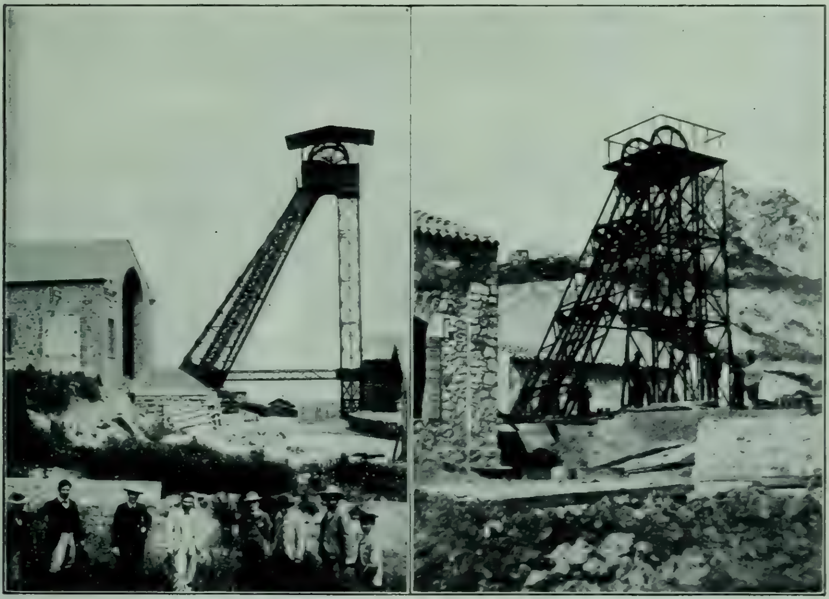
The sulphur occurs naturally in layers or beds, included in the rock of calcareous sediment containing gypsum or clay belonging to the tertiary period, or, to speak precisely, to the miocene. Its formation is due to hydrochemical causes which acted upon calcium sulphate. The causes of this transformation are not yet thoroughly understood, so that as yet we have only hypotheses. The most favored hypothesis is that powerful emanations of hydrocarbons, coming from lower layers and under enormous pressures, acting upon the calcium sulphate in solution or during its deposition, reduced it to sulphur and lime.

SURFACE WORKINGS FOR SULPHUR, WITH WASTE HEAPS OF EXTRACTED ORE.

The usual form of the beds is that of a horizontal lens. In fact, by reason of the almost circular and concave form of the bottom of the basins and the law of molecular attraction acting at the moment of the sedimentation, if there was no disturbing cause they would not have been able to take naturally any other form than that which they ordinarily have, The abnormal forms, which are seen in some deposits, come from several accidental causes. It is to be noted, however, that all the deposits have a greater thickness in the middle and a smaller one at the ends, and have greater richness in the central layers than in those near the top or near the edges.

After making the borings necessary to obtain an exact idea of the depth, thickness, and direction of the deposit, other work of no less importance is taken up, that is to say, construction of passages of entry to the deposit, so as to be able to exploit it. These passages may have various forms; the layer of mineral may be reached by horizontal galleries, by inclined planes, by galleries of more or less steep slope, or by vertical shafts (as seen on page 200). Ordinarily the shaft has the double purpose of extraction of mineral and withdrawal of water; but the two functions are sometimes fulfilled by the same passageway, and sometimes by separate ones. The former case occurs when a special installation of pumps is not available. In the latter case the shaft is divided longitudinally by means of cross pieces and vertical timbering into three sections. Through two of these sections the cages for the hoisting of the mineral move without interruption; in the third, the pumps for extraction of water are installed, with pipes, conduits, air chamber, and accessories. The single-action pump is situated near to the sump at the bottom of the shaft, and its powerful pistons are able to raise the water in a single jet up to the mouth of the shaft, even if it is 200 or 300 metres above. The pumps are usually driven by electricity.

The most insidious and serious dangers in the mines are the gases, which develop within the rocks and rush out impetuously during the work. In the solfataras those commonly occurring are hydrogen sulphide, carbonic acid, and marsh gas. The first is poisonous, the second asphyxiative, and the third inflammable and explosive. Hydrogen sulphide is contained in the sulphurous waters. For this reason, whenever one is about to come upon a body of sulphurous water, the characteristic odor of putrefied eggs is observed. It attacks the mu-



SCENES OF MINING ACCIDENTS IN THE SICILIAN SULPHUR DEPOSITS.

The headworks on the left are at the Trabonella mine. The manager, Mr. Loria, who is shown (in a white suit) standing in the midst of a group of students from the mining school of Caltanissetta, was killed by an explosion of fire damp in October, 1903. On the right is the Guilia shaft of the Trabia mine. Here Comm. Richard Travaglia and Chev. Louis Fiorentino were killed by hydrogen-sulphide poisoning in August of the same year, other engineers in the party being saved by the heroism of a head workman.

cous of the eyes, which become red and dry, can not bear light, and suffer sharp pain, extending to the temples. It also attacks the respiratory passages, through which it is absorbed into the blood, and produces immediate poisoning.

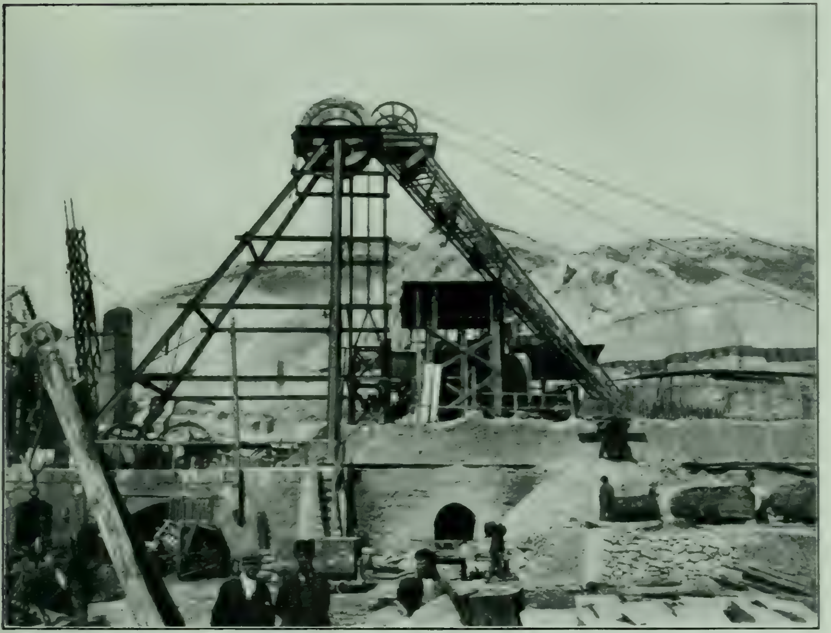
The carbonic acid is produced by the decomposition of the calcareous and argillaceous tufas, or it may be enclosed in the cavities of the calcareous rocks. It manifests its presence by extinguishing the lamps and causing fatigue in breathing. If one notices its presence, it is necessary to go immediately to fresh air, as it is utterly unfit for respiration.

Marsh gas, or carburetted hydrogen, is the terrible fire-damp, which claims so many human victims in coal mines. It has neither color nor odor, and that is why its presence is not observed, until, having accumulated where work is going on, having mixed with oxygen and come into contact with the flame of the lamps, it causes a terrible explosion.

It should be mentioned here that safety lamps for oil or benzene, like the Davy lamp and those which are derived from it, do not fulfil their purpose, and electric incandescent lamps are the only ones which completely satisfy the exigencies of service.

When the necessary works for reaching the deposit of sulphur

INCLINED PLANE AND MECHANICAL HAULAGE PLANT, STINCONE MINE, S. CATALDO.



TRABIA MINE. HEADWORKS OF THE MAIN HOISTING SHAFT.

are finished, the working begins by the extraction of the mineral, which is done by hand laborers with pickaxes. One or two work together during the day, and one or two during the night in each underground passage. The shift of laborers thus takes place every twelve hours. Each laborer is provided with a pickaxe, timbers, and one or more willow baskets. One or two of the pickaxe laborers have at their disposal one or two or several "carusi (see page 206), whose duty it is to carry out the mineral in sacks or in wooden wheelbarrows. Sometimes they carry the material to the exterior of the mine, sometimes to the end of the gallery communicating with the shaft or inclined plane by which it is hoisted, and sometimes they fill little cars which move upon rails and which the "vagonieri" push to the shaft, from whence they are drawn up to the outside. Taking account of work days and holidays, of days of greater and of less activity, the average amount extracted in a year by a single pickaxe laborer may be calculated as nearly 400 cubic metres. Besides the pickaxe laborers, the "carusi" and the "vagonieri," there are other workers in the mines called "spesalori," who have special charge of making all necessary repairs to the passageways, of all rubbish and disposal of waste material, and of all the ventilation passages through the barren rock.

In the exploration of the deposit as to its thickness and width, parallel galleries are made, which reach as far as the barren rock. After this the method of working is chosen. The most rational method is one which is recommended by practicality, safety and economy. It is called "per ripicui" (method of filling in), and offers the following advantages:

CARUSI, OR CARRIERS OF SULPHUR FROM THE MINES.

1. Prompt use is made of all mineral that exists in the mine.

2. Systematic provision is made for cutting out the masses that are included between the galleries and cross-galleries.

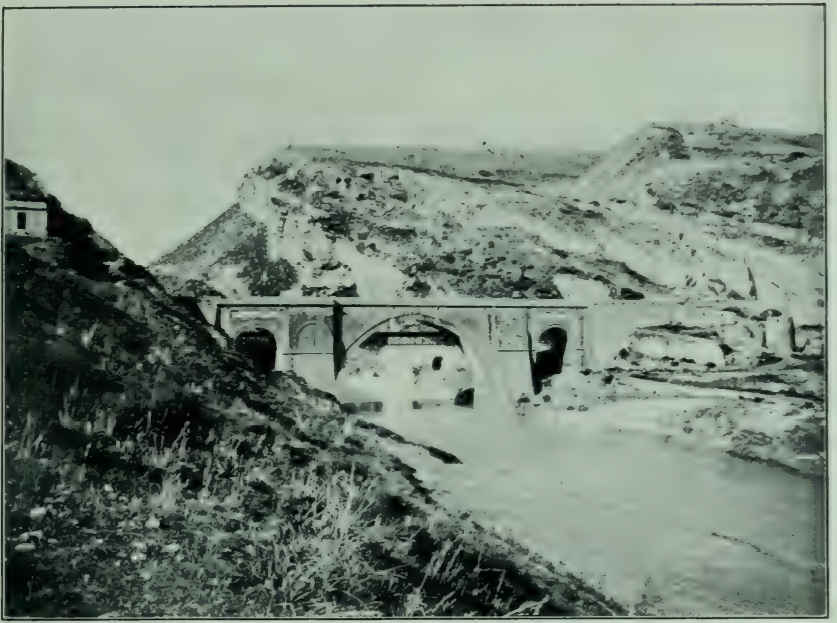
3. The safety and solidness of the mine are provided for.

4. The considerable expense of maintaining the galleries is avoided.

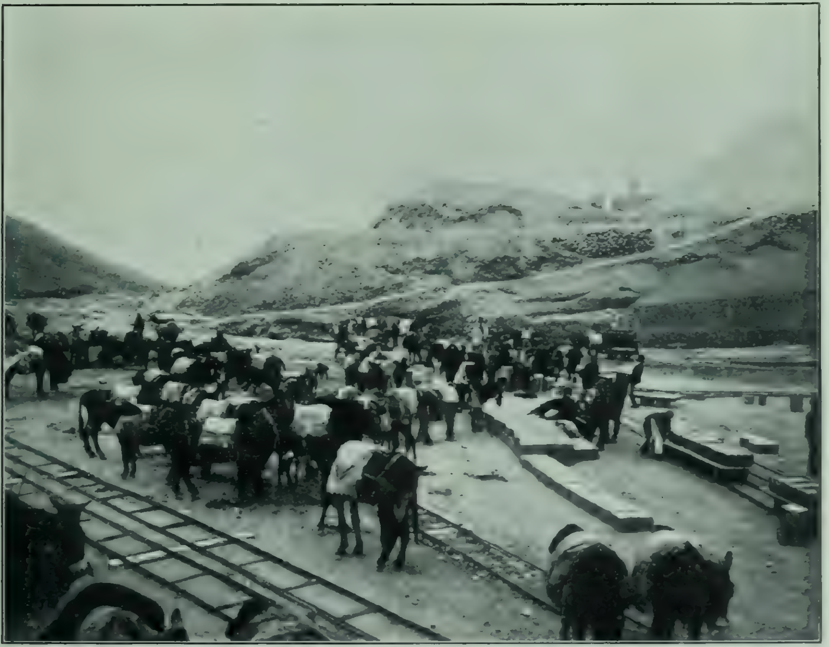
5. The expense is avoided of getting rid of the barren material, which often occurs within the sulphur deposit.

6. The danger is avoided of the accumulation of deadly gases in abandoned galleries, which usually spread to the place where work is in progress.

The slight difference in density of specific gravity between sulphur and its gangue prevents its separation by sorting or washing. The sulphur industry thus has no other method at its disposal but that of fusion, or of distillation. The fusion is the most important operation in the sulphur industry, and requires special care and intelligent and thoroughly practical direction. A very rich mineral, of which



CAPODARSO BRIDGE, CALTANISSETTA, SHOWING THE PLIOCENE TUFAS OVERLYING THE SULPHUR-BEARING STRATA OF TRABONELLA.



TRANSPORTATION OF SULPHUR, ASSARO, SICILY.

the melting is not properly understood, will yield less than a poor mineral, of which the fusion is understood; while the latter will not give anything if the fusion does not succeed.

FURNACES FOR THE FUSION OF SULPHUR FROM THE ORE, QUATTROFINIATE MINE.

The open furnace in which the sulphur itself is used as fuel, is called the "calcarone"; it is so common in Sicily, and also in the mines of the main land, that it may be said to be superior to all other apparatus of fusion. An improved modern modification of the calcarone is the Gill furnace, named after its inventor. These furnaces are built in groups of two or three, back to back, and communicating with each other. They are cylindrical in shape, and covered by a dome, at the center of which there is a circular opening. Their capacity varies from 8 to 48 cubic metres per furnace.

A remarkable improvement has been made quite recently by using steam as source of heat, instead of burning the sulphur; the Gill furnaces are thus transformed into closed furnaces, the fusion of the mass of mineral contained in them being effected by internal heating. These closed furnaces consist of a double-walled iron chamber, upon the bottom of which is fastened a pair of rails connected with a small railway outside, by which two or several little iron cars with gratings at the bottom and filled with mineral are introduced into the chamber. When the chamber is closed the intense heat developed causes the fusion of the sulphur in the little cars; it flows through the grating and collects, by means of a channel, in a reservoir outside of the chamber; from there it is cast into moulds. A few minutes are sufficient to complete the fusion. Then the hinged door is opened, the little cars are withdrawn with an iron hook, others are introduced containing mineral to be melted, and the operation is repeated again and again.

The laborers in a mine may receive a daily wage, or may be paid by contract for a definite quantity of work. The pickaxe men are paid by day, receiving 2 to 3 francs daily; the "carusi" get 0.75 to 1.50 francs, and the "vagonieri" from 1.50 to 2.50. The contract price paid is from 12 to 30 francs per box (of 4 cubic metres), or even more, according to the distance of the working passage from the point where the material is to be delivered, the hardness of the rock, the quantity of worthless matter mixed with the mineral, and the means used in extracting it.

One who does not wish to manage a mine may let contracts for the exploration, excavation, extraction, and fusion of sulphur of the whole mine, or of a single part of it. Contracts are made on the basis of the quintal of sulphur fused. The usual price varies from 2.50 to 4.00 francs, according to the expense of production and delivery of the mineral. From that price, 1.70 to 2.20 francs are deducted for the expenses of shafts, machinery, etc.

The exploiter of the mine would be able to make better conditions if he could escape certain onerous terms ordinarily established in contracts with proprietors of mines. Among others there is one by which the exploiter can not free himself from the proprietor in case he has capital of his own, or finds someone who will supply it to him on better terms. According to the richness of the mineral, 20 francs borrowed for a few months may give interest of 2, 4, or 8 francs, or even more; that is equivalent to an annual interest of 40, 50 or 60 per cent., or even more.

The technical personnel consists of engineers and experts, who usually come from the universities, higher technical schools, and mining schools, and who have the licence and the scientific and technical knowledge necessary for the proper management of a mine.

The price of commercial cast sulphur varies according to its quality. According to the custom of trade, three classes are made, first, second, and third. Each of these classes includes three subclasses, superior, good, and ordinary. The purchase of sulphur is made by merchants, who sell it again to the manufacturers who transform it; or it is purchased by brokers who buy for foreign houses, or by men who sell to factories where derived products are made, or even directly by the factories. The sulphur which the producer sells to merchants at the mines is destined to undergo numerous transformations, according to the use to which it is to be put; it contributes to other industries, and is the source of many derived products.

That which goes to the refinery is melted again, distilled, purified, and then sold to textile factories and spinning mills for wool, cotton, and silk, which make use of the decolorizing and bleaching properties of sulphurous acid. The mills which reduce the sulphur to powder sell their products to the farmers, who make use of the insecticide properties of acids of sulphur; to manufacturers of explosives, who make use of its inflammable property; and to tile makers, who furnish tiles for northern countries, and make use of the property of resisting severe frosts which clays acquire when mixed with sulphur. The sulphuric acid factories, which burn the solid sulphur into acid in leaden chambers, sell their product to chemical factories. The sulphate of soda is used in soap making, in various kinds of glass making, and in pottery. The sulphate of copper is used in dyeing, and for the preservation of wood for building, for the disinfection of grains, and for the cure of vines infected with peronospora. The sulphate of iron is used in dyeing, in painting, and in the disinfection of wells and drains. The sulphate of potassium is useful in fixing the colors of cloths; that of aluminium, in tanning; and those of magnesium and of zinc, in medicine, the former as a purgative, and the latter as a mild caustic. The extensive use of sulphur and its derivatives is the reason why it finds a market so readily.

OBSOLETE METHODS AND CURRENT PRACTICE IN SHOP ADMINISTRATION.

By Egbert P. Watson.

New and important movements, in the first flush of their power, are apt to be carried to extremes, and the modern tendency toward "system and organization" is probably no exception. It does not impugn the necessity of systems to large works to admit that small works have no doubt, in some cases, been seriously overburdened by elaborate and complicated commercial and clerical organizations which their productive capacity did not require and could not well support. Mr. Watson's review sounds a note of conservatism which will be welcome to many who find themselves unable to follow the modern pursuit of "system" to the extremes occasionally advocated.—The Editors.

THE whole trend of modern machine-shop practice—indeed, of all manufacturing involving the use of machinery—appears to be toward constant increase in the search after and adoption of labor-saving appliances, on the one hand, and constant increase in the development and elaboration of systems, on the other. The entire movement seems to me to be epitomized in the recently published "Second Labor-Saving Number" of this Magazine.* A careful reading impressed me with the great value carried not only by the articles, but also by the illustrations, in the way of information and suggestion of the methods followed in conducting various departments of many well-known plants. But these seemed to me to be at the same time witnesses to something which has, possibly, been overlooked by managers, and this is the very large clerical force required to do what is, in many cases, routine work.

If these persons were all of them in the nature of handy men—that is, first-class laborers—and receive the pay of such helpers, they would still be an onerous tax on the pay roll; but in one department at least, the average rate of pay must be $3 per day. In a force of fifty men this means $150 per day, or $45,000 per annum, for the salary list only of one branch of the business. Doubtless the managers have seen this expense and considered it warranted—indeed, necessitated—by the system in force in their own particular shops.

Now, system is neither more nor less than method. All shops have some way of working which is best adapted to the conditions of the work and the idiosyncrasies of those who direct the actual operations, and there are nearly as many systems as there are shops. Managers

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* The Engineering Magazine, July, 1904.

"read, mark, learn, and inwardly digest" what is being done by others, and adopt such parts as seem good to them, with innovations or changes to meet their own needs. It is scarcely possible to take up a technical journal, or even a trade paper, that has not an illustrated system of some kind for producing goods, all of which goes to show that in the making of systems there is no end. A difficulty with many of them is that a slight departure from routine involves or is the cause of much friction all along any given line. Few systems are elastic enough to admit of changes of form without throwing everything out of gear. An example of perfect harmony of action is found in an automatic machine, say for producing wood screws, or pins. The material goes in at one end and comes out of the other commercially perfect; the process is wholly mechanical; but when the human element is introduced by systems, there is always the possibility of derangement through the fallibility of man. This is only a roundabout way of saying that no system is perfect, as many have found to their cost.

This brings me to say that system is possible in a draughting department to a limited extent only. The filing of records, or cataloguing of plans for different machines and their details, is simple; but this cannot be said of plans for new machines, or tools of any description in process of re-construction. After they have been completed they become part of the records and cause no trouble, but until they are some one has to "watch out."

Suppose, for example, that a certain standard machine is to be changed in one detail to suit the needs of a customer. It is to have a platen with a ball joint at the bottom, so that it can swivel in all directions to work at any desired angle. All of the regular patterns of the standard machine can be used except the old platen, but the feed-gear must be altered to act on the new platen. All through the works, every one connected with the production of the new-old tool has to be advised of the alterations, in spite of the fact that the drawings for the alterations are for changes, and are *not* the standard machine. This interferes with the routine established for the old machine, with which all concerned were perfectly familiar, and throws the system out of mesh for such time as the changes are going on, or until every one has become familiar with them.

In large measure, also, it accounts for the enormous force required in some drawing rooms, for in many instances new men have to be taken on to attend to new work, or new-old work, and these men are kept regularly thereafter, or for some time, in case of exigencies that after all may not arise. It is beside the question to say that radical changes in standard machines should never be made; that is as it may be. As part of the business policy of a works, the responsible parties may be justified in filling every demand of consumers, but it seems wholly probable that it is costly advertising.

Comparison of concerns of equal standing in similar lines of trade are scarcely possible, as a criterion by which to judge whether one or the other is not well managed; but judging by surface indications and observations made on the premises of both by a person familiar with all the operations carried on, there are marked differences. One shop which made all kinds of work, and made changes as they were desired, had a force of ten or twelve draughtsmen, while the other had twice as many. The same is true of the clerical force, or those who are not actually employed at handicrafts; modern shops seem to require much larger staffs than concerns whose output in dollars and cents was very large fifty years ago.

The shop in which I was an apprentice in 1851 employed in good times about 3,000 men of all trades. The work was chiefly engines and boilers for all uses, sugar mills, pumps, stationary and marine engines, etc. There was great variety in the work and the character of it, for the engines were of several types—oscillating, inverted-cylinder, inclined, overhead-beam, side-lever, and others. Drawings were required for all parts, and the forgings and patterns were made from the machinists' drawings, with allowance for finishing. By this method but one set was needed for the job, not only reducing the cost but preventing errors by duplications. I never saw more than four men in the drawing room at any time, and the chief draughtsman was outside superintendent a large part of the time and did but little actual work at the board. There were no blue prints in those days, so each working drawing was made upon heavy drawing paper, figured to dimension with good plain figures, mounted on a suitable board, and varnished with shellac. Then the drawings went into the shop and were followed accurately to the figures marked on them. Such a thing as an error or mistake from going by the drawings never occurred to my knowledge, and if there had been I should have found it out, for, like the average boy in the shop, I had my nose into pretty nearly everything in those days. The drawings were simply removed from the boards when the job they belonged to was finished, and filed in drawers for further use unless too much worn; when they were in this condition a new drawing was made at once and filed so that the set would be complete.

Now it seems to me that this was a very good system indeed, as I recall it, and one that accomplished all that was required with a minimum of office force and time. It must be remembered, too, that there were no adventitious aids to business records in those days—no type writers, no adding machines, no loose-leaf ledgers or their equivalent, no card systems of reference, nothing whatever to reduce labor, or save time. Everything required manual and mental energy, and it seems to me at this distance from the theatre of operations that the clerical force employed fifty years ago to look after and keep track of an establishment working 2,000 men ordinarily, and one-third more when in full blast, accomplished a great deal with no more than the usual systems. To recapitulate: there were three men and an assistant in the office proper; one of these was a timekeeper. There were four draughtsmen, and two men in the store room to give out files, red lead, etc. That was the whole clerical force, and it was housed in a small two-story building across the street; the main office was a small back room about twelve feet square.

Now the amount of work turned out annually by this concern was very large for the times, and by no means small at this day. There would be four or five beam engines from 750 to 3,000-horse-power, with their boilers and paddle wheels—and let no one imagine that these last were a small factor in the labor question, for they are all work from the first to the last. It was hand work, too, for machines cannot be used except in drilling holes, and not always then. There would be some stationary engines building, with their boilers, and, in addition to the new work, a lot of steamships and steamboats to be repaired, beside the general overhauling of factories in the vicinity periodically. Altogether hundreds of thousands of dollars worth of work were turned out yearly, every bit of which had to be carefully followed up for financial leakages. The time keeper was a man well along in years, who went around morning and evening among the men to see what they had been doing, and he personally interviewed every single man. No foreman handed him a report of what men were present or absent; he got the live voice of every person in the place, and if any one was absent when the time keeper came around he was docked half a day, upon general principles, to teach him to be in his place at the proper time. This dockage was restored the next pay day upon absolute proof that the workman was in the shop, but unavoidably absent for the moment. For instance:—an apprentice, let us say, found himself 50 cents short on pay day; upon presenting his pay envelope, the contents of which were marked in ink on the outside, he was compelled to explain where he was before the 50 cents would be refunded. In most cases he had been out of the shop with a gang upon repair work; then he would have to give the name of the foreman of the gang, and obtain his endorsement upon the envelope that he had put in full time, before he could get the shortage made up. The actual paying of wages was very quickly accomplished—inside of an hour, I think, for the whole force. They assembled outside the works after six o'clock in a certain order—all the boiler makers first, then the blacksmiths, pattern makers, coppersmiths, and others. Each man's name was called and he stepped forward; on a fast walk the whole shop was paid off without a hitch. The time keeper and a clerk did the whole business every week, and complaints were few and far between. Now if it is borne in mind that the time keeper had a long distance to travel twice daily, up and down many pairs of stairs, and aboard ships when there were any in the dock, it will be conceded, I think, that he earned his money. Are there are better systems in vogue to-day which can pay off and keep track of 2,000 men of all trades, check their time, and make up the pay roll by the labor of two men only?

In the machine shop proper, where all the work was set up, I am free to say there was no system whatever, except the supervision of the foreman to see that the tools were kept going and the fitters employed. There was a tool room, or an apology for one, where some tools were kept when the man who took them out happened to remember to bring them back, but there was no penalty for "losing" them, and it was currently believed that some of them found their way to neighboring junk shops. There were no arbors, or mandrels as they were then called, each man making one as he needed it from a piece of scrap iron, with centers struck by a common punch. After they had been used for a day or so the condition of them can be imagined.

It must be borne in mind that the machinists' art was very imperfectly developed half a century ago, and things which seem incredible now were common practice then. The machines themselves left much to be desired as regards accuracy and fitness for their purposes, and in this direction there is no computing how much machinists owe to tool makers for their enterprise and skill in furnishing lathes and planers, to say nothing of special tools, that are absolutely accurate. I can look back now and see where we wasted time and money by cut-and-try methods which would not be tolerated in these days, and where, for want of accurate measuring machines, one man's inch was 33-32 while another's was only 31-32. This was not through carelessness or want of skill, but was caused by the want of system which permitted every man to furnish his own standards. In this direction modern practice cannot be too highly commended; what with limit gauges micrometers, etc., there is no reason why an inch in Georgia, for instance, should not be an inch elsewhere.

There are several kinds of work which come under the generic term of machine, but they differ from one another in degree only; all of it is metal work, whatever may be its class. A man who has learned his trade in a machine-tool shop is a machinist, but he is not capable of marine work until he has learned the differences between the two classes. In one, the former, the fits are close and exact, while in the other there is a certain freedom required in some details so that they can come and go slightly to avoid heating. I mention this because in discussing ways and means we must consider the instruments, human agencies, by which desired ends are to be attained. It makes all the difference whether the man or men we employ are of a high class morally and mentally, or mere hewers of wood and drawers of water, without ambition to rise in the world. This applies as well to the heads of departments as it does to the workmen themselves; temperament enters largely into the question of the success of systems, of whatever nature. A designer of systems or methods to get out work may have all the constructive faculty there is, and yet fail because of inability to direct and carry out his conceptions in concrete form.

I can make this clearer, possibly, by saying, referring to a preceding page, that modern machine making requires the services of a class of men who are quite distinct in their several lines. For want of a better name they are called tool makers; they supply all the small tools, jigs, and appurtenances of whatever name or nature that are needed to do work accurately and expeditiously. Necessarily, these men must be versatile, or able to do everything possible and impossible, one would say at times, that metal is capable of. Not only this, but they must be quick of apprehension, and wholly free from personal bias as to ways and means to accomplish certain things. This requires considerable tact, for there is nothing more annoying to an experienced designer who has, presumably, surveyed the limitations of his ideas thoroughly before fixing them in metal, than to have a well-meaning workman begin to suggest different ways of arriving at the same result before he is asked to give an opinion in the premises; and just here the designer has need of all his self control to give the soft answer that will show the workman that he is exceeding his privileges; he may have more ingenuity than the "super" has the exercise of, but a little common sense would show him that it is bad policy on his part to put it in evidence. Good tool makers are scarce, and it is a curious fact that the result of their work is to lessen the visible supply of general machinists—that is, men who can run any tool, are handy at the vice bench, and can read drawings at sight.

Jigs are mandatory; there can be no misinterpretation of their edicts; it is impossible to drill holes in the wrong place or of the wrong size with them, the whole procedure being definitely fixed beforehand; this being the case, the workman has no mental work to perform, not even as to the sequence of operations, for, in many establishments, these are listed for him by some one in authority. In turning, the shapes of tools are also prescribed, his vagrant fancies or predilections in favor of his own shapes for certain parts of the work being tabooed. All this routine work seems to me to be destructive of originality and improved methods, for those followed are conservative. This view of the matter is taken by some firms, who have foreseen the possibilities and allowed for them by establishing a system of reward for suggestions from the shop force which may be adopted as betterments.

In arriving at these conclusions I have been careful to get the views of others upon the subject, and find, as might have been expected, that there are some who feel that good, all-around, versatile mechanics are no longer required. The practice of specializing and fitting up shops to manufacture stated lines of work is so general that the demand for men who can fill any place in a machine shop, equally at home on machine tools, vice work, or the floor, is becoming smaller annually, so that it is only a question of time when the old-timer will be as extinct as the dodo. In opposition to this I have quoted papers and instances from articles in THE ENGINEERING MAGAZINE which show that firms are taking great pains with their own pupil-apprentices to give them a full knowledge of all branches of the trade so that they may obtain a thorough knowledge of it. This was conceded to be the custom, but it was asserted that good mechanics could not be made by such methods, for the time spent in each branch was too short to gain an extended working knowledge of the trade; moreover, such men, so soon as their terms of apprenticeship had expired, found that they could get higher wages as specialists than they could as general utility men, so they learned to do one thing well instead of many things superficially.

As to the force of this aspect of the subject I am not competent to speak, for I have had no acquaintance with specialists; but I have a wide circle of friends engaged in businesses of a mechanical character, requiring a good working knowledge of the machine trade. Their views are that versatile mechanics are badly needed at the present, and that the time will never come when they can be dispensed with. From my own point of view I have observed more ordinary machine shops where work is carried on by the usual machine tools than I have those whose output is produced by special devices. I have visited many of these last also, and had, a few years ago, a very thorough knowledge of the systems followed—necessarily so, for I supplied much of the material used in many of them. For certain operations there were special machines, but the entire outfit was not of this class, and there were a good many men at work who might be called general machinists.

Enough has been said for purposes of comparison between obsolete and current methods in shop systems. The necessity of the latter in one form or another is unquestionable; the results will show for themselves, when a balance is struck, whether they are profitable or the reverse. It is worthy of note, however, that the enormous gains said to have been made by reducing the time for certain kinds of work, by offering bonuses, by high-speed steels, and by special tools, have not resulted in reducing the cost of machine tools to consumers of them. Not having a list of average prices the country over, or of those which prevailed half a century ago, I cannot draw parallels, and impressions are valueless in this connection. Whether profits are greater now than they were fifty years ago, must be left an open question; but there is no doubt at all that in the matter of surroundings, conveniences, and comforts of one sort or another, workmen are far better off than they were years ago. I need only specify the lavatories, lockers for clothes, lighting and heating of work rooms, to say nothing of latrines, retiring, and bath rooms, where every convenience is provided, to prove my assertion. These things cost the administration a round sum annually to keep up, and they are under no legal obligation to furnish them. Wages, too, have doubled in amount in the half-century. I do not include the upkeep of libraries, free schooling for apprentices, free dining rooms, etc., in my citations because they are not universal, but even cursory examination will show that the sanitary conditions of shops is much higher in the scale of civilization than it was.

I confess myself puzzled, however, when I see the mechanical aids to mental labor in counting rooms, and the very large staffs of employees to use them. One would say that the reduction of time and labor brought about by them would tend to reduce the force as well, but it seems to have the contrary effect. I am told by some who know more about modern systems than I do, that it is a part of certain methods employed, and they admit it is expensive, but not so much so as it would be to dispense with it. I talked with a friend now in business for himself who was at one time in the employ of a concern that did an enormous business, sending out six hundred invoices daily, and no shipment was permitted to be made until the invoice had preceded it. They had an office force of about a dozen persons, and have since increased it. I asked if any mechanical aids were employed, and was told that an adding machine was used on long columns of figures; that was the only one. Now it seems curious that if, fifty years ago, three or four men could take care of a million dollars a year, it should require ten times that number to do work now to the same amount. I said this to my friend, and he replied that it was doubtless owing to the difference in the nature of the business and the systems employed. I answered that in the first instance there was no system as such; in the second, that their system was an enormous tax on the annual output, to which he assented, inferentially, by silence. I should have stated before that the concern above mentioned did a retail business connected with manufacturing, which accounts for the large number of invoices made out daily.

In a certain sense, systems inaugurate themselves, for where there is an established line of work to be turned out facilities must be provided to do it at the lowest possible cost. This means a system or plan of procedure of a routine character, the one adopted being, in a great measure, governed by the character of the job. My view is that systems will increase in number, and are increasing, but that there will always be a certain amount of work which is so variable that hard-and-fast lines, or special machines and processes, cannot be adopted.

THE TESTING OF STEAM ENGINES.

By Capt. H. Riall Sankey and C. Humphrey Wingfield.

Captain Sankey and Mr. Wingfield review, with admirable conciseness, the development of engine-testing practice, and present very clearly its mechanical aspects and its practical importance. The study is very interesting in its exposition of the fact that the use of electric power has furnished both the demand and the means for the more accurate testing of steam engines.—The Editors.

ALTHOUGH the systematic and accurate testing to which practically every steam engine is now subjected dates only from the commercial use of the dynamo, tests of some sort were carried out in the very earliest days of steam-power practice.

In 1774 Smeaton tested a Savery steam pump, and found it raised 100 cubic feet of water per minute to a height of 14 feet with a consumption of 3 hundredweight of coal in four hours. In working out the result he gave the "duty of the pumping plant" as "5,250,000 foot pounds of work per bushel (84 pounds of coal.)" In modern units this is equivalent to about 32 pounds of coal per hour per effective horse power.

About the same period Smeaton made many trials of Newcomen engines which gave duties varying from 3,250,000 to 7,500,000 foot pounds per 84-pound bushel of coal. As these engines appear to have been used exclusively for pumping purposes, it was natural to take the pump power as the measure of work done, and this was adopted by Watt also for pumping-engine trials. Indeed, the practice of stating the work done by a pumping engine in millions of foot pounds of work developed while burning a given weight of coal has continued to the present day.

Watt's engines were in demand for general power purposes where horses had previously been employed, and he often had to guarantee that a proposed engine would satisfactorily replace a given number of horses. Savery, in 1712, had estimated that a pump developing 3,080 foot pounds per minute was equivalent in power to one horse. Smeaton ascertained that about 22,000 foot pounds per minute might be taken as the average work of an ordinary horse. Watt, however, felt that he could not base guarantees on an average result, so he experimented [1784] with a powerful London dray horse. He found that it could do work at the rate of 33,000 foot pounds per minute, a unit ever since known as "the horse power." He appears, however, to have used this unit chiefly for commercial purposes, still expressing the results of trials in terms of millions of foot-pounds duty per bushel of coal.

Independent Testing of Steam Engines.—As pointed out later on by Mr. Mair,* "an engine uses steam and not coal," but it was not till the middle of the nineteenth century that this began to be realised and that engineers made attempts, when testing the efficiency of engines, to avoid confusing the issue by including in the final efficiency that of the boiler.

J. Farey [1849] compared the steam consumption of two engines by noting the temperature of the discharge from a jet condenser.†

G. A. Hirn [1856] suggested as a general principle in engine tests the comparison of the heat supplied to the engine with the heat rejected to the condenser. This principle is the foundation of the modern system of accurate engine testing.

W. B. Farey [1868] described a calibrated "tumbling bay" or weir for accurately measuring the quantity of water discharged per minute from a surface condenser during an engine trial.‡

Mr. Emery [1874-5] conducted some very careful steam-consumption trials on the American steam vessels "Bache," "Rush," "Dexter," "Dallas" and "Gallatin." The start feed water was measured by two calibrated tanks which were filled alternately, the feed being pumped from the one last filled.¶

Michael Longridge [1880] made a very complete trial of a compound engine, and expressed the results as a "heat balance."§

The same experimenter [1881] tested a horizontal compound engine at Blackburn. On this occasion Hirn's methods were applied for probably the first time in England, and a very complete heat account was given. The measurements of feed and condensed steam were by measuring tanks and tumbling bay respectively.**

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* *Proceedings of the Institution of Civil Engineers,* XCIII, p. 203. *Engineering.* XXXVII, p. 154.

† *Engineering.* VI, p. 58.

‡ This apparatus was afterwards described in great detail on p. 97 Vol. XIX of *Engineering*, where the method is given of calculating from observation the number of B.Th. U. carried off by the exhaust steam per indicated horse power—a quantity which was called "the constant" of the engine tested.

¶ *Engineering* XIX, pp. 14, 129, 133, 153 and 177. Summary of trials XXI, p. 124. An engraving of the measuring apparatus appears on p. 139, Vol. XIX, *Engineering*. The original report of these trials by Messrs. Emery and Loring appeared in the Report of the U. S. Treasury Department, Washington, D. C., Nov. 4, 1874.

§ *Engineering*, XXXI, p. 166.

** *Engineering,* XXXIII, pp. 174, 220, 242 and 266.

J. G. Mair [1882] published the results of testing a number of engines independently of the boilers, the trials being conducted on Hirn's principles. The air-pump discharge was led into a tank from which it escaped through a submerged hole, and the rate of flow was measured by the height at which the water stood above this hole, the equivalent rate having been found by trial. The feed was passed through a measuring tank.

P. W. Willans [1888] read his first paper on "Trials of a Non-condensing Steam Engine," in which he described the methods of steam-engine testing which he had devised for use at Thames Ditton. He introduced the plan of weighing instead of measuring the water; using a single tank large enough to contain the whole of the water required for a given trial, which was mounted on the platform of a weighing machine and connected to the feed pump by a flexible pipe. This tank having been filled and balanced, the sliding weight on the steelyard of the weighing machine was set to correspond with the weight of water which would be left in the tank when a pre-determined amount had been pumped into the boiler. As soon as this amount had been withdrawn by the pump, an electric bell was rung by the falling of the steelyard and the pump was stopped.

The method of weighing is more accurate than that of measuring, as it is difficult to hit off the exact height of the water in a measuring tank. Although it may be assumed that this error is as often plus as minus, it is possible that this may not be so, and in such a case the cumulative errors of the large number of measurements taken during a trial might be considerable. By substituting one weighing for a number of measurements, Willans eliminated this source of error entirely. As losses through leakage and weeping at the safety valve were not directly accounted for by measuring the feed, separate trials were made to ascertain their amount and the gross weighing corrected accordingly.

Although very great accuracy was thus attained, the corrections were laborious and required considerable skill on the part of the observers. Mr. Willans therefore abandoned the plan of weighing the feed, and thereafter adopted that of condensing the exhaust steam and weighing it instead. Where it was desired to run at atmospheric pressure, the air pump was disconnected and the flow of circulating water to the surface condenser adjusted to give the desired back pressure; the water being led direct to the tank through the nearer of the two pipes in the engine.

In the course of the discussion of a paper (1891) by Mr.

Crompton on "The Generation and Distribution of Electrical Energy," Mr. Willans published* his discovery of what is known as the "Willans' law," viz., the fact that part of the steam used by a given engine running at constant revolutions and expansions varies directly as the indicated horse power, the remainder being constant at all loads.

In his second paper,† read after his death, Mr. Willans used this law as a powerful instrument for interpreting the results of the trials of a condensing central-valve engine. Greatly improved methods were described, the principal departure from those given in his previous paper being the substitution already referred to, of weighing the exhaust steam instead of the feed water. Instead of setting the steelyard to indicate the gross amount of steam to be used during a trial, the tank was first balanced and the sliding weight then adjusted to indicate a comparatively small additional amount, for instance 100 pounds. As soon as the steelyard indicated, by ringing an electric bell, that this weight of condensed steam had reached the tank, the time was noted, the weight pushed forward another 100 pounds, and so on to the end of the trial. In this way a number of points were obtained on a consumption curve, and a very satisfactory check obtained on the final result. So extremely accurate has this method proved, that it is found the results of a 20-minutes trial give the steam consumption as exactly as a trial of several hours duration.

The establishment [1888] of a test house as part of an engineering works, in which all the necessary instruments and means of using them were provided, marked a very great step in advance of previous practice, and it is probable that Messrs. Willans & Robinson's works at Thames Ditton were the first to be so provided. The testing of an engine is thus reduced to a routine; no test stands by itself, but forms one of a series; the assistants are specialists, and any error is at once detected by comparison with similar cases. Other firms soon followed the example thus set, and it is now becoming exceptional for an engineering works to be without its test house.

As one of the most modern examples, the description of that erected at Rugby by Messrs. Willans & Robinson will be of interest. Engines to be tested are placed on trucks and run direct from the erecting shop to "the test," where electric travellers take charge of them and place them where required.

Steam is provided by a battery of four Niclausse boilers (Figure

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* *Proceedings of the Institution of Civil Engineers*, CVI, p. 61.

† *Proceedings of the Institution of Civil Engineers*, CXIV, p. 2.

2), of which as many as are required for the tests in progress are connected to a main steam pipe which runs along the side of the building at the back of the engines at a convenient height. Another pipe, parallel to this but at a lower level, contains water kept under pressure by a centrifugal pump, which is used for circulating purposes in the condensers. During an engine trial the pipes marked "condenser discharge" in Figures 3 and 4 are connected to other pipes, sunk in the floor, which serve to carry off the waste circulating water to a cooling pond and to conduct the condensed steam to the weighing tanks.

There are two of these tanks, one of which is seen in Figure 3, and by using them alternately a continuous test can be made extending over any number of hours. The condensed-steam pipes terminate immediately over these tanks, and three-way cocks are provided so that the water from either system of pipes can be directed into the tank desired through bent pipes, one of which is shewn in the figure. The steelyards connected to the platforms on which these tanks stand are in the adjoining weigh room, a view of which is given in Figure 5.

The consumption is measured by an assistant standing at the table seen in the figure, above which is the dial of a standard clock. All being ready, and the engine, condenser, etc., connected to the nearest branches on the several pipes already referred to, the engine and dynamo are allowed to run until temperatures, output, etc., are normal. The assistant then slightly overbalances the steelyard (Figure 5) by means of a jockey weight, and notes the instant when the lever rises as the commencement of the consumption test. Signals by means of electric bells ensure that the records taken periodically by indicators, counters, and electrical and other instruments, are simultaneous. The method of logging the water in equal weight increments has already been described.

Objects of Engine Tests.—Scientific testing for purposes of research or for obtaining data for improvements will not be touched upon in the present article. It is proposed to deal only with commercial routine tests, made either to prove that a guarantee has been fulfilled or to obtain data for future guarantees of efficiency.

For this purpose it is necessary to measure:—

(a) The power-producing agency (heat units received by the engine).

(b) The work developed in the cylinder (indicated horse power).

(c) The effective work done, and incidentally,

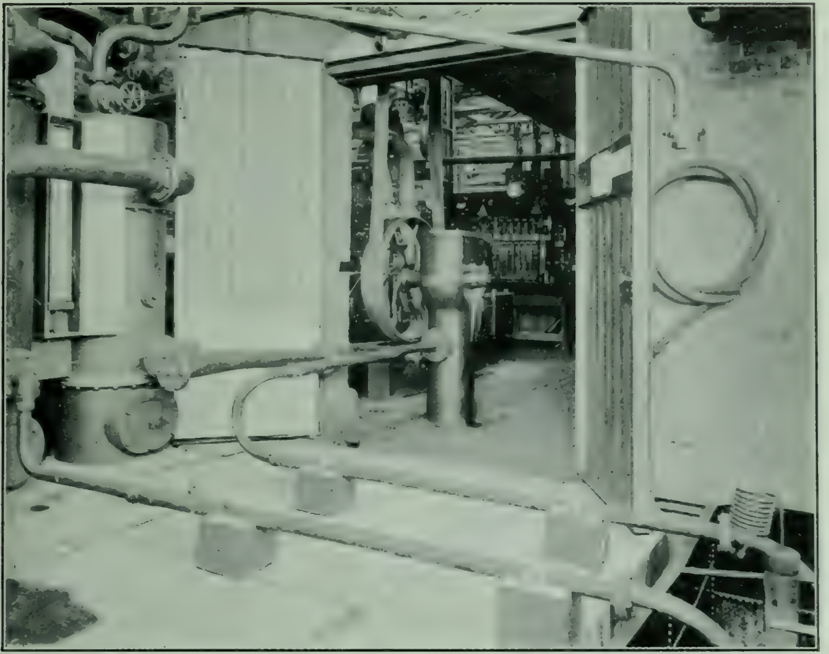


FIG. 1. THE ORIGINAL COMMERCIAL ENGINE-TESTING PLANT AT THAMES DITTON.

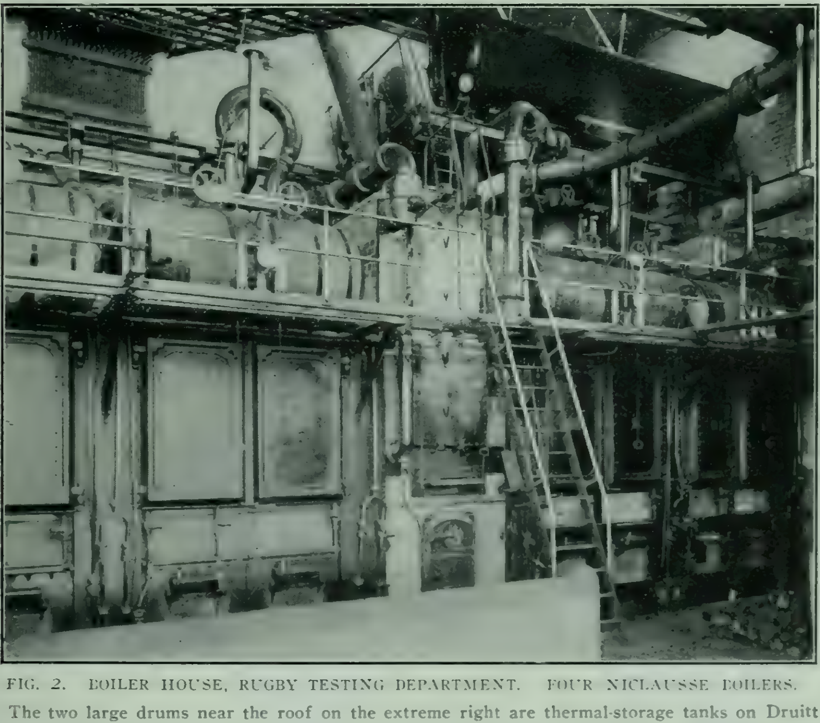
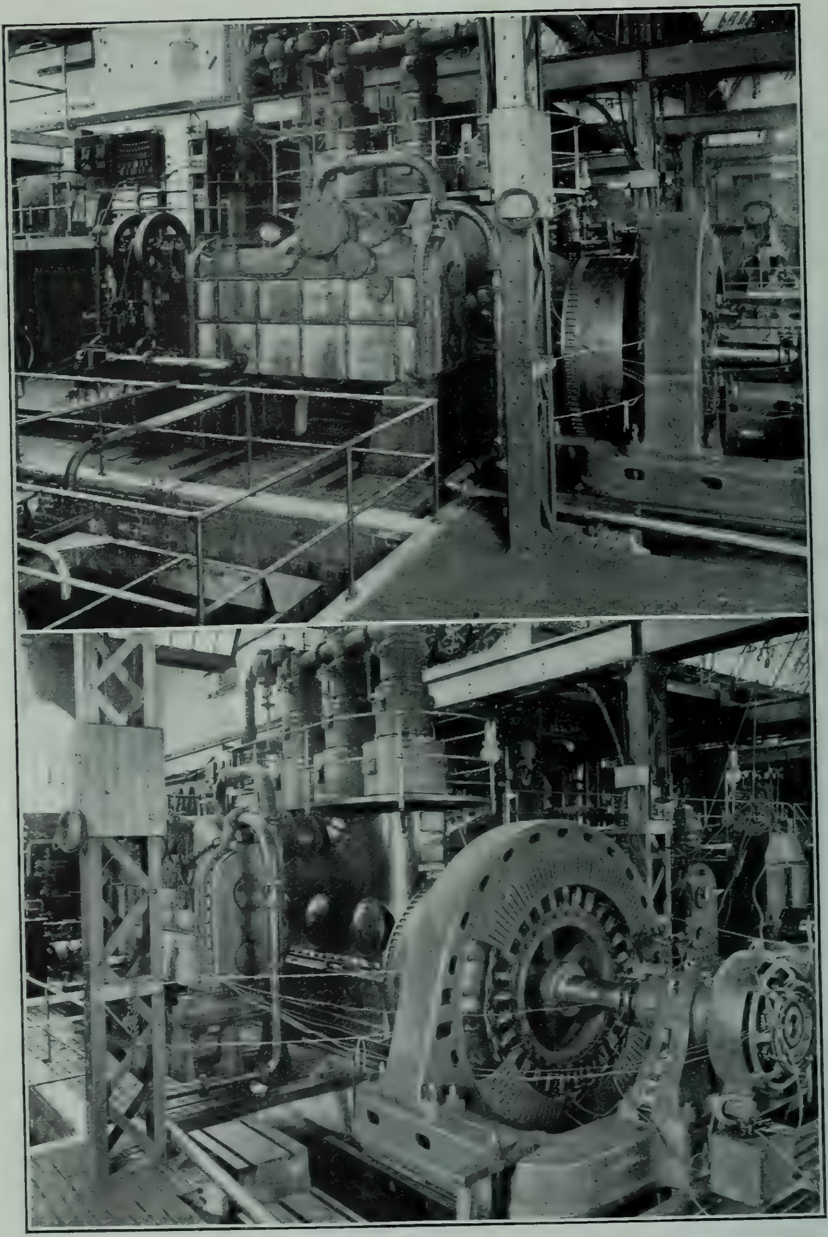


FIG. 2. BOILER HOUSE, RUGBY TESTING DEPARTMENT. FOUR NICLAUSSE BOILERS.
The two large drums near the roof on the extreme right are thermal-storage tanks on Druitt Halpin's system. The brickwork in the centre contains an independent superheater.



FIGS. 3 AND 4. AN ENGINE UNDER TEST.

Weighing tank is seen in the pit in the foreground (upper picture); the bent end of a pipe leading from the three-way cock mentioned in the text hangs over the tank; the discharge from the air pump is led direct to it by the pipe resting on the lower hand rail. The engine with two flywheels, on the left, is the air pump; the air-pump suction is clearly seen leading from the condenser. Condensers and air pumps are moved about as required by electric travelers. In the gallery at the back are the switchboards, balancing coils, and rheostats.

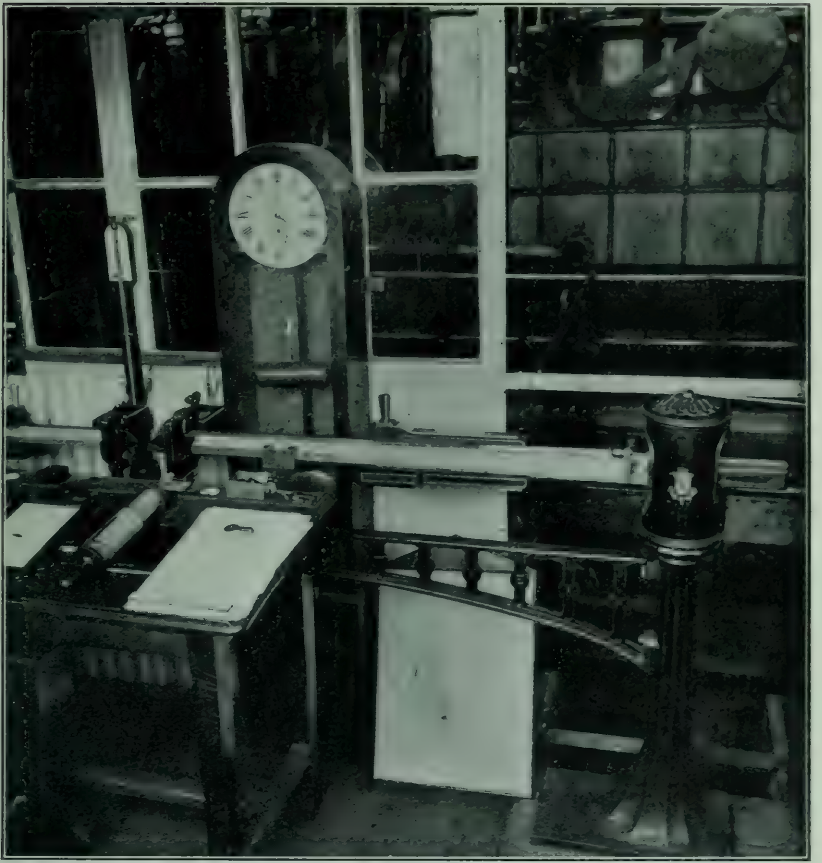


FIG. 5. PART OF THE INTERIOR OF THE WEIGH ROOM.

The weigh room is divided from the electrical-instrument room by a partition to the left of the table. The spots of light from the reflecting galvonometer are thrown on a translucent scale on a panel in this partition, and thus are seen from the table in the weigh room. The nearest steelyard connects with the platform carrying the near tank in Fig. 3. The one just seen on the left connects with a second tank. The large sliding weight keeps count of each 1,000 lb. water of condensed, the smaller one registering smaller increments. The wires leading from the contacts at the end of the lever serve to ring a bell when the steelyard rises.

(d) The work used up in driving the engine itself, which is of course the difference between (b) and (c).

Thermodynamic Measures of Energy Supplied to a Steam Engine.—As a direct measure of the heat units supplied to a steam engine is not obtainable, an indirect process has to be resorted to, and the heat is measured by ascertaining the weight of steam used in a given time and multiplying it by the number of heat units known to be contained in each pound, as shewn in the following table:—

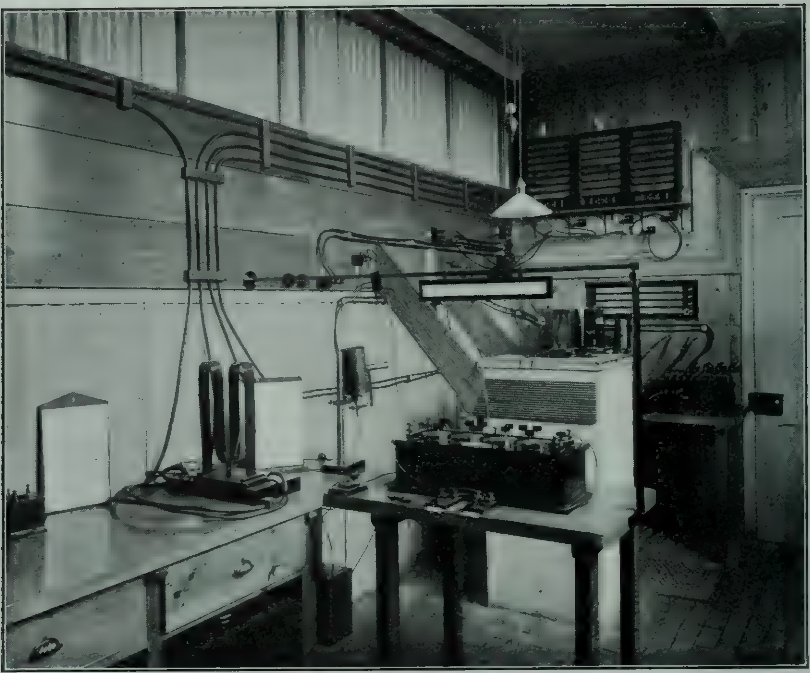


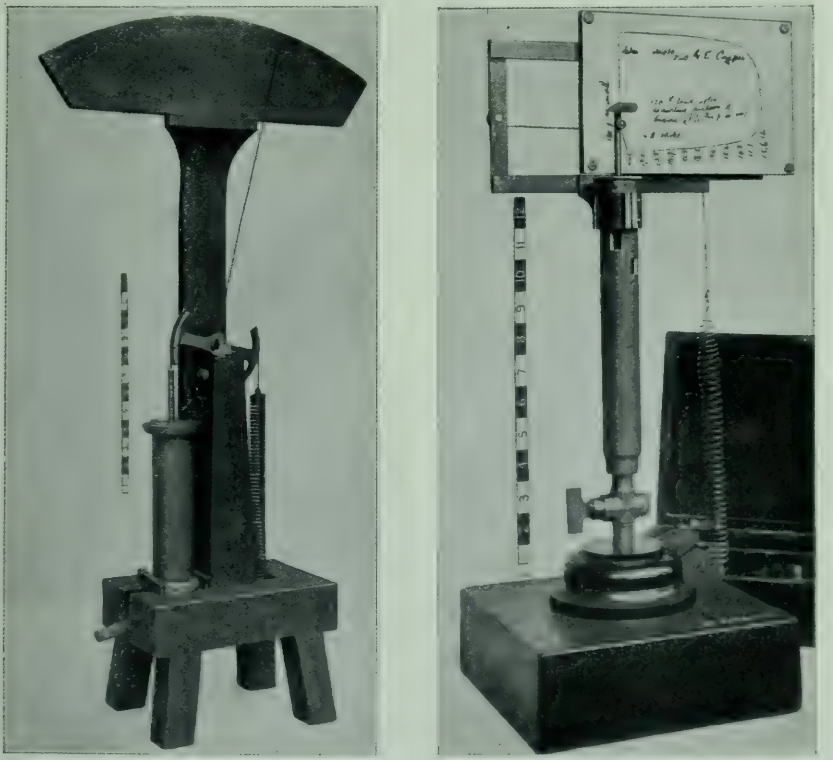
FIG. 6. THE ELECTRICAL INSTRUMENT ROOM.

This is on the other side of the partition from the weigh room. The four translucent scales referred to on page 237 are seen just at the left of the door. Three of the reflecting galvanometers standing on the pedestal reflect onto these scales; the fourth faces the other way and reflects onto the suspended scale. Three of the illuminating electric lamps are just below the translucent scales; the fourth is more in the foreground, near the Wheatstone bridge. The M-shaped strip of metal on the left is a standard low resistance.

(1) Kind of Motor.	(2) Heat Value of Fluid.	(3) Quantity of Fluid Used per I. H. P. per Hour.	(4) Data required to determine (2).		
				Condition.	Quality.
Steam Engine.	B. Th. U. per pound of steam.	Pounds of steam used per I. H. P. per hour.	Pounds pressure per square inch.	Wet Saturated or superheated.	Dryness Fraction. .... Temperature.

Until superheated steam came into use the heat units per pound of steam were so nearly constant that it was usual to compare the weights of feed water per indicated horse power without correction when judging of the relative merits of steam-engine performances. The heat value of a pound of steam now varies so largely that a committee of the Institution of Civil Engineers has recommended that either the number of British thermal units per indicated horse power per hour should be given, or that the actual weight of steam used per indicated horse power should be reduced to an *equivalent* amount under standard conditions when reporting a trial. For this purpose a standard pound of steam is assumed to contain 1,100 available British thermal units. This corresponds to the heat value of one pound of saturated steam entering the engine at an absolute pressure of 170 pounds per square inch and leaving it at a pressure of 2 pounds per square inch (absolute).

Measurement of Work Done by the Working Fluid on the Moving Parts of the Engine.—This is invariably obtained by measuring the mean pressure exerted by the steam or other working fluid during one cycle of the engine. The instrument used for the purpose is the familiar "steam-engine indicator." It is not proposed to enter into a minute description, but it may be interesting to compare Watt's original instrument (Figure 8) with Figures 9 and 10 which shew



FIGS. 8 AND 9. THE WATT INDICATOR. THE WATT-SOUTHERN INDICATOR.

By the courtesy of *The Engineer*.

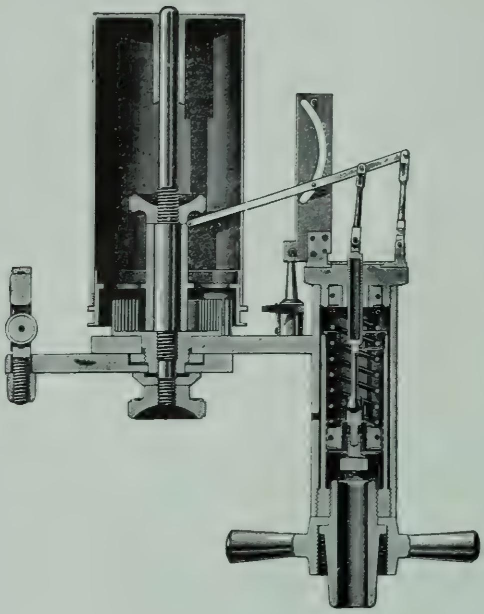


FIG. 9. TABOR INDICATOR.

two modern kinds. Even when all precautions have been taken when using an indicator, there are so many possibilities of error that it is not safe to base calculations on one set of cards only, and several should be taken and those selected which give concordant results.

There are many ways of measuring diagrams. The most exact and certainly the most convenient is by the use of Amsler's planimeter. When the needle at the end of one arm is fixed by pressing it upon the drawing board, and the style at the end of the other arm is passed round the diagram, the roller, which has previously been set at zero, indicates by the scale on its edge the area in square inches which is enclosed by the card. Dividing this area by the length of the card in inches gives its mean height in inches. As the "scale" of the spring used (i. e., the fraction of an inch which the pencil rises for each increment of one pound pressure) is known, the mean height divided by this scale gives the desired mean effective pressure. The method of calculating the indicated horse power when this pressure and the area and

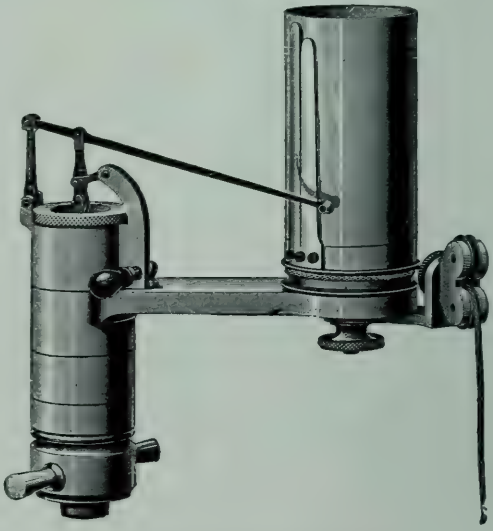
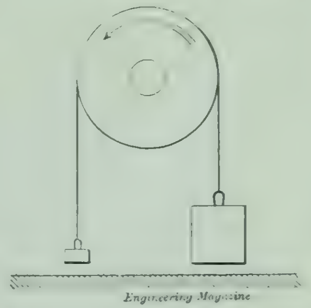


FIG. 10. CROSBY'S INDICATOR.

speed of piston are known is too familiar to need description here.

Measurement of Effective Work Done.—As already mentioned, this used to be obtained by multiplying the weight of water pumped by the height in feet to which it was raised. At the present time engines are used for a multiplicity of services, and they are usually tested by making them raise a weight at a given rate (brake horse power or B. H. P.), or drive a dynamo, the output in electrical energy being expended as electrical horse power (E. H. P.)

Brake dynamometers are usually one of two kinds—solid or fluid brakes. The simplest form of solid brake is perhaps Thompson's rope brake. It consists of a pulley over which a rope is passed, to the ends of which are attached a heavy and a light weight respectively (Figure 11). If the wheel were stationary the heavy weight would cause the rope to slide in a direction opposite to the arrow, thus doing work equal (in foot pounds per minute) to the distance fallen in one minute multiplied by the difference of the two weights. If the speed of sliding is V feet per minute, it is clear that by turning the wheel in the direction of the arrow at this circumferential speed the weights will remain stationary, the rate of sliding and therefore of doing work remaining the same. Hence the rule to find the foot pounds absorbed per minute by *any* form of brake dynamometer is first to adjust matters till the weights are balanced while the shaft revolves, secondly to calculate the velocity in feet per minute with which the weight would be raised if, instead of slipping round the wheel, the brake was clamped to it, and thirdly to multiply the weight in pounds by this velocity. Division by 33,000 reduces this product to brake horse power.



Engineering Magazine

FIG. 11. THOMPSON'S (LORD KELVIN'S) ROPE BRAKE.

As an example:—suppose a weight (Figure 12) of 100 pounds hangs at a distance from the axis, which, measured horizontally, is 6 feet, and that the pulley runs at 300 revolutions per minute. The weight, if the brake did not slide, would be rising at the same rate as if the rope were wound round a big drum D of 6-feet radius. Hence the work is equivalent to raising 100 pounds at the rate of $(2 \times \pi \times 6 \times 300 = 11{,}310$ feet per minute, and the power $= \frac{100 \times 11{,}310}{33{,}000} = 34.3$ brake horse power.

Springs are often substituted for weights (as in Figure 13, for instance, which is a variation of Figure 11). The forms of brake dynamometers vary considerably but the general principle is always the same as described. A jet of water is usually kept playing on the inner side of the brake-pulley rim, and scoops remove it so as to keep up a constant circulation of water, but for very high powers it is difficult to prevent the brake and pulley becoming too hot, as will be seen when it is remembered that the whole of the work done is converted into heat, and a brake invented by W. Froude * is then frequently used. Figure 14 shews it connected to an engine ready for trial; Figure 15 is another view, an electric motor being under test; and Figure 16 shews its internal construction. It is something like a centrifugal pump, but the disc and sides are constructed to render the free flow of water as difficult as possible. Figure 19 shews an annular section developed, and it will be seen that the water will be dashed from the outer ends of the pockets in the disc to those in the

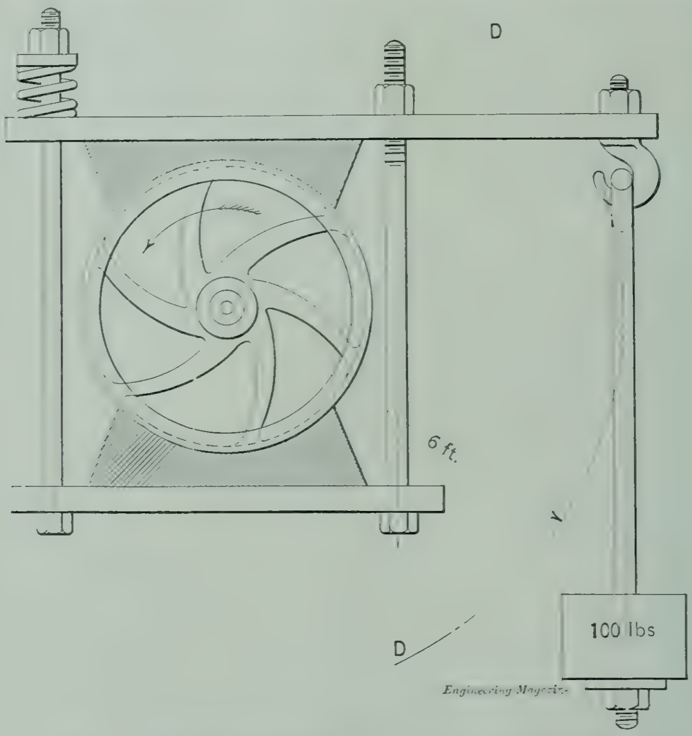


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FIG. 12. DIAGRAMMATIC SKETCH OF A BRAKE DYNAMOMETER.

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* A very full description appeared in *The Engineer*, Vol. XCIII, p. 616.

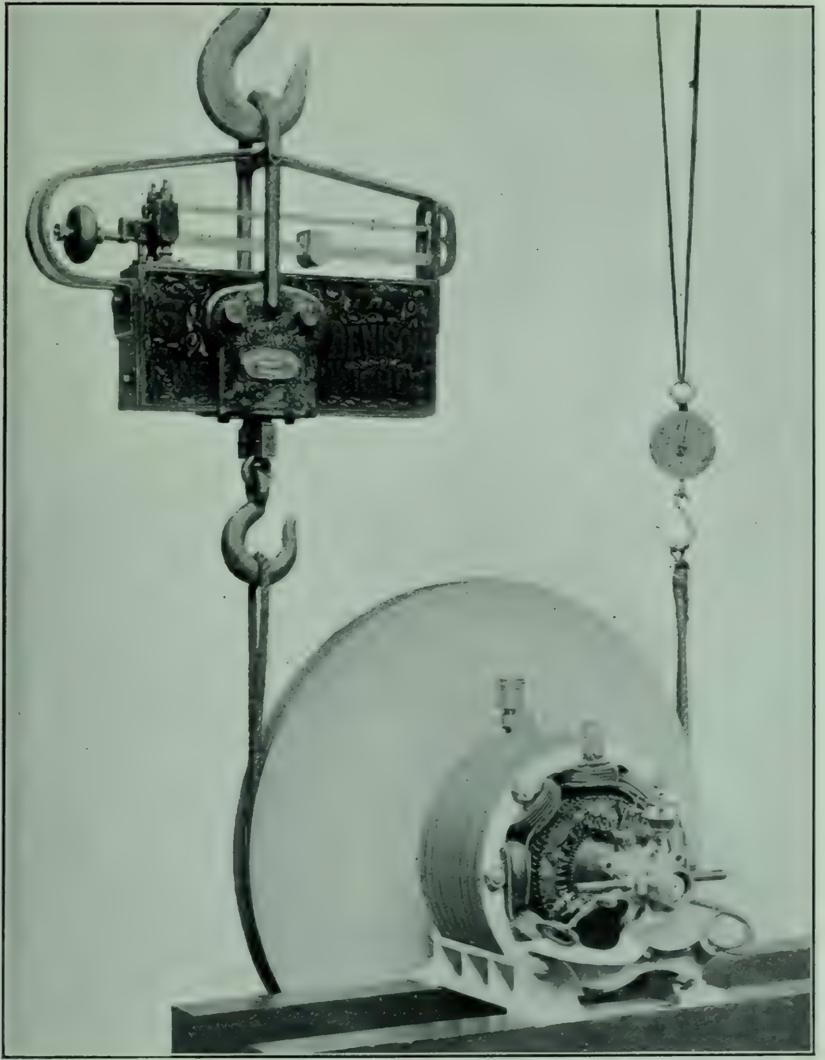

FIG. 13. A MODIFICATION OF THOMPSON'S ROPE BRAKE.

sides, in each of which it spins in a vortex and then flows back again to the centre of the disc. The consequent tendency to rotate the casing is resisted by a lever carrying a weight, as in the friction brake already referred to, the only difference being that fluid resistance is substituted for "solid" friction. The brake horse power is calculated in the same way as described above. A flow of water is maintained through the Froude brake (entering by the small holes near the centres of the divisions), which serves to carry off the heat generated when absorbing the horse power. If the rise in the temperature of the cooling water is noted it is easy to calculate how much energy is absorbed as heat by the water, if the number of pounds passing through the brake per minute are known. With the addition of the relatively small amount of heat lost through radiation and conduction through the metal, this should agree with the power measured by the lever and weight, thus forming a useful check.

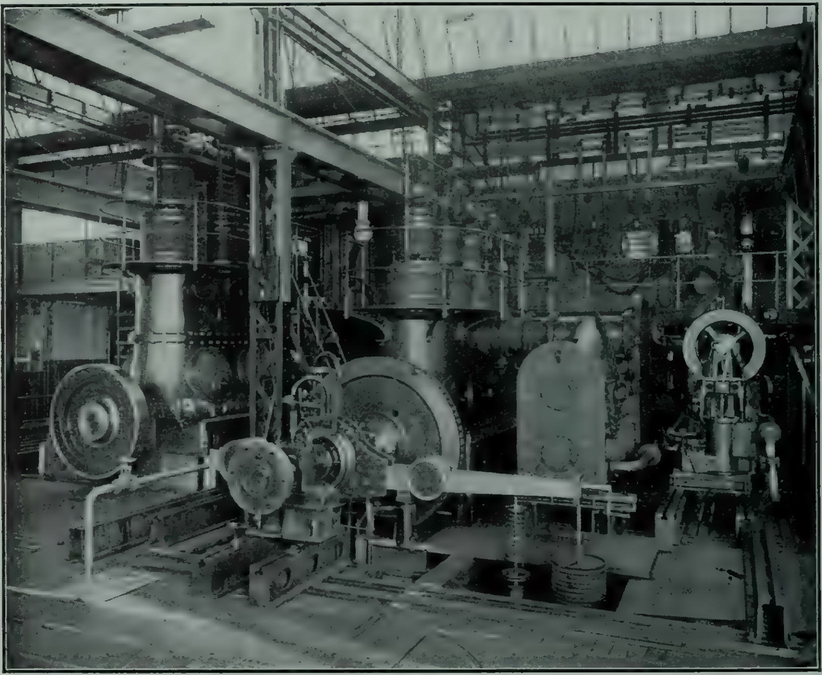

FIG. 14. FROUDE'S HYDRAULIC BRAKE DYNAMOMETER MOUNTED ON AN ENGINE UNDER TEST.

A condenser and air pump are seen to the right; the pipe to the left supplies circulating water to the brake. The spring under the beam is connected to the piston of a dashpot, and facilitates the adjustment of the sliding weight to obtain steady readings.

In cases where an engine is required solely to drive a dynamo, the latter forms a most satisfactory and accurate equivalent for a brake, when the losses in the dynamo itself have been ascertained. Moreover, it is perhaps the most satisfactory mode of testing the power of such an engine from the purchaser's point of view, since he wishes to know only what is the smallest expenditure of heat (or feed water) with which he can obtain the desired electrical horse power or number of kilowatts.

As an engine test is useless unless the accuracy of all instruments can be guaranteed, these are calibrated at frequent intervals. Figure 20 shews the apparatus made and used by Messrs. Willans & Robinson for testing pressure gauges, indicator springs, etc. Steam or water, according to the nature of the test required, is admitted by the valve at the top of the receiver, and its pressure adjusted till the vertical sleeve, carrying the required number of circular standard weights, is just supported. This sleeve is hung from the top of a very accurately gauged plunger sliding in a vertical tube connected at its lower end to the receiver. Nozzles round the latter, fitted with cocks, serve for the attachment of the apparatus under examination.

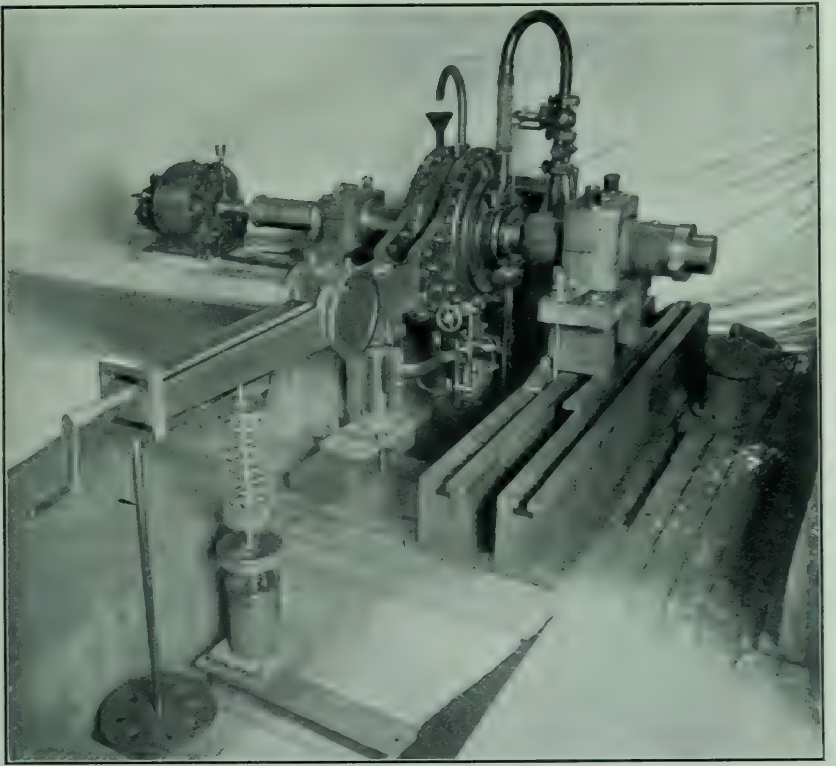

FIG. 15. AN ENLARGED VIEW OF THE HYDRAULIC BRAKE DYNAMOMETER.

Showing the flexible-tube water supply and bent-tube discharge, and the winch handle for adjusting the sliding weight. The pawls on this weight act as pointers for taking readings on scales engraved along the upper edges of the lever. In this figure the brake horsepower of an electric motor is being taken, and as this is small, the dead weights at the end of the lever, shown in Fig. 14, have been removed.

Space will not admit of description of the thermometers, calori-

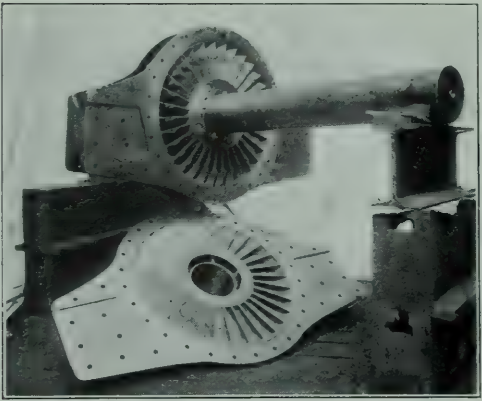

FIG. 16. HYDRAULIC DYNAMOMETER BRAKE WITH ONE COVER REMOVED.
The water enters through the small holes at the centres of the partitions.

meters, and other instruments used, but some of them are illustrated in Figures 17 and 18.

In testing steam dynamos, the current produced by the dynamo and the voltage have to be observed; the current varies from a few amperes to some thousands of amperes, and voltages vary from a few volts to 10,000 volts, provision having to be made both for continuous and alternating currents. It is evident that without very carefully designed instruments a large number of different instruments would be necessary, since measurements accurate to 1/3 of one per cent. are required.

At the Victoria Works, Rugby, the system used for the measurement of continuous currents was designed by Captain Sankey and

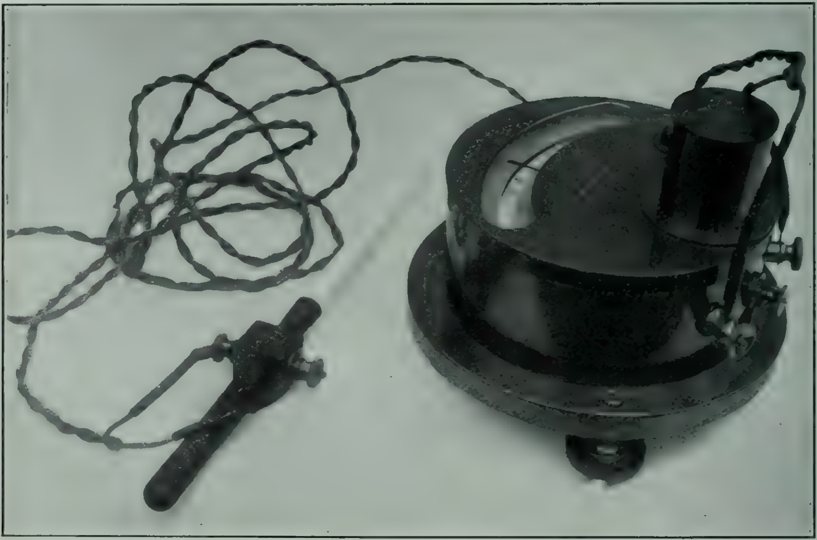

FIG. 17. CALLENDER'S THERMOMETER AND TEMPERATURE INDICATOR.
Cambridge Scientific Instrument Co.

the late Mr. F. V. Anderson, and the adaptability of one of the instruments to measurements widely different in magnitude is considerable. In measuring current the same instrument is used to measure 2,000 amperes and 1/500,000 ampere, accurate to within 1/3 of one per cent., and a similar instrument is used to measure voltages between 1,000 volts and 1/1000 volt. The system used is a direct deflection method. The current from the machine passes in its circuit through a standard low resistance of a few ten-thousandths of an ohm, which is mounted on the wall behind the gallery (Figure 22). These resistances are made of platinoid strips cast into copper terminal bars. The difference of potential across these resistances is measured, and is proportional to the current flowing, the temperature correction being practically negligible. Two potential wires from this resistance are led to a galvanometer in the instrument room (Figures 6 and 7), and in circuit with this is a resistance so adjusted that the reflecting galvanometer shews amperes direct on a transparent scale so arranged as to be seen by the assistant at the weighbridge. By using main resistances of different capacity and magnitude, currents of largely different value can be easily measured.

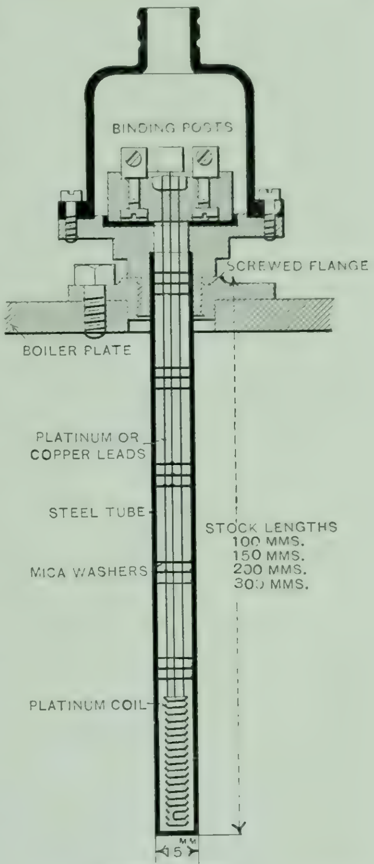

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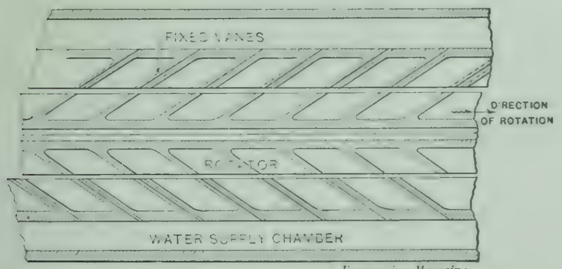
FIG. 18. INTERIOR ARRANGEMENT OF CALLENDER THERMOMETER.



Engineering Magazine

FIG. 19. DIAGRAMMATIC REPRESENTATION OF THE BLADES AND CASING OF A HYDRAULIC BRAKE.

The measurement of voltage in the case of continuous currents is done in a similar manner to that used for the measurement of currents. Two leads from the machine terminals are connected to the ends of a special resistance of 250 ohms. The potential drop caused by the passage of the current through one one-hundredth of this resistance is indicated on the galvanometer directly in volts, by adjusting a variable resistance in series with it. If the voltage of the machine be over 200 volts, two or more similar resistances are put in series. As an additional check, a Crompton potentiometer is sometimes employed.

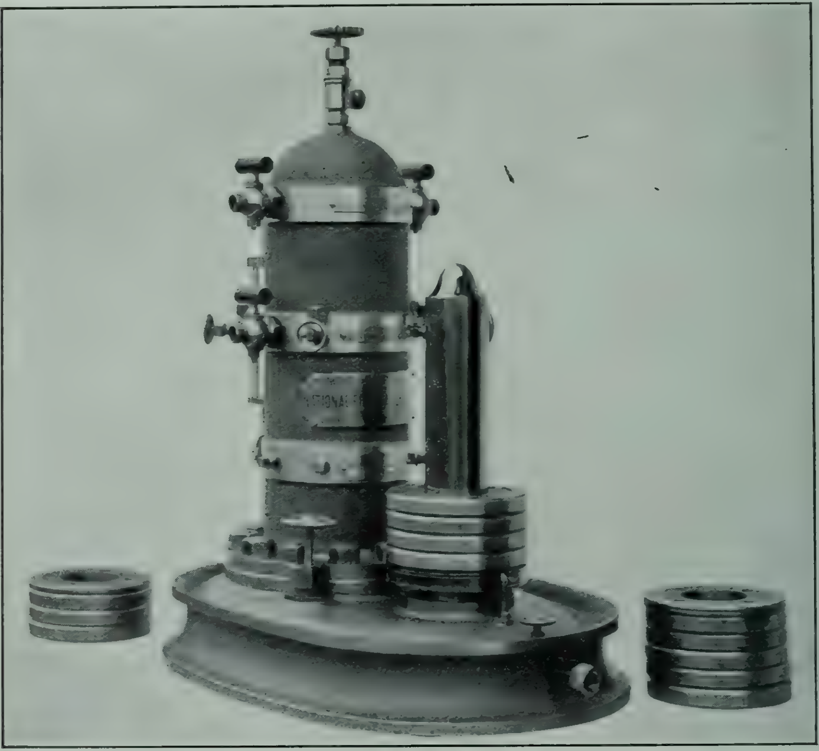


FIG. 20. APPARATUS FOR CALIBRATING PRESSURE GAUGES, INDICATOR SPRINGS, ETC.

The instruments are attached to nozzles on the vertical receiver. Steam or water is admitted at the top, and adjusted to support one or more of the round standard weights when placed on the vertical sleeve at the right, which sleeve is hung from an accurately-turned plunger of exact area, sliding in a tube connected with the receiver.

For alternating currents a complete set of instruments has been installed on the system worked out by Mr. G. L. Addenbrooke since the photographs were taken. They comprise an ammeter, a volt-

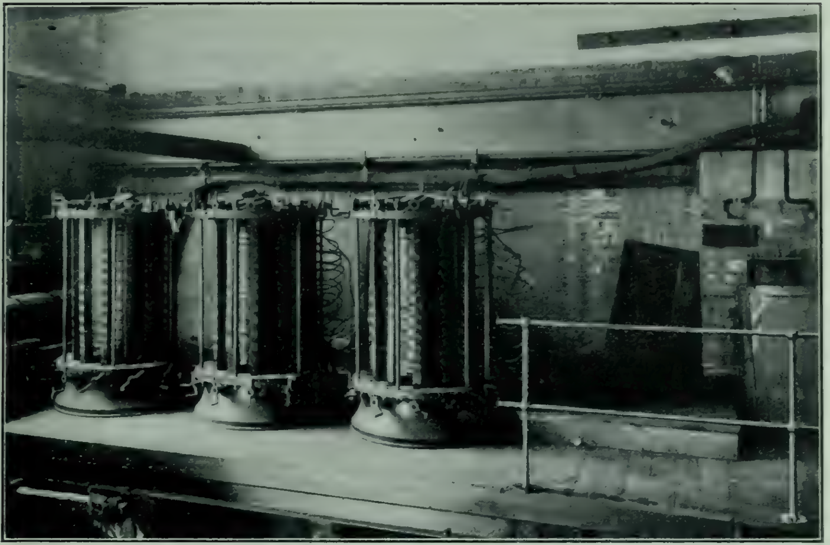


FIG. 21. GROUP OF TRANSFORMERS IN THE GALLERY OF THE TESTING DEPARTMENT.

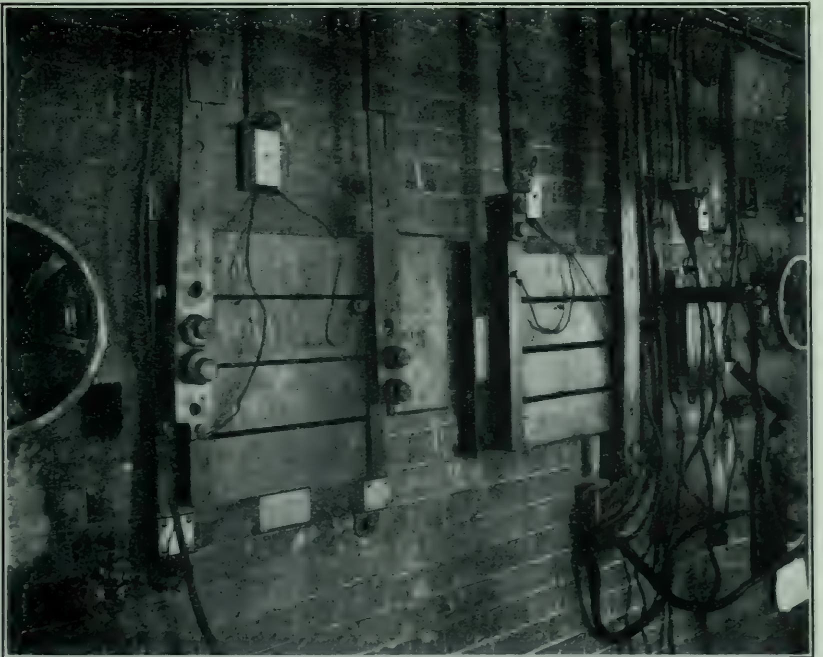


FIG. 22. RHEOSTAT IN THE GALLERY OF THE TESTING DEPARTMENT.

meter, and a wattmeter, and are all static instruments of the Kelvin quadrant type. The wattmeter shews true watts, and from it and the apparent watts shewn by the voltmeter and the ammeter the "power factor" is at once obtained. This method, like that used for continuous currents, has been designed so that all the instruments can be calibrated by the Clark or other standard cell, this being done at regular intervals, and at any time any reading on the scale can be reproduced and its true value determined.

In order to be able to test an engine and dynamo under the conditions of ordinary working, choking coil transformers (Figure 19) have also been installed in the gallery at the back of Figure 3, so that any desired amount of induction can be put into the circuit, and the actual conditions of running can be imitated, the induction required being obtained by adjusting variable air gaps in the magnetic circuit.

The current generated by the dynamo under test is absorbed by resistances both of wire and liquid types. As these are of the ordinary pattern, no special description need be given.

MODERN ELEVATOR TYPES AND ELEVATOR PRACTICE.

By Howard S. Knowlton.

Mr. Knowlton points out the intimate part which the elevator plays in the movement of modern city life. His practical study of the various types—their characteristics, advantages, and limitations—is interesting and valuable to those who are installing and to those who are using or operating, as well as those who are designing, elevator plant.—THE EDITORS.

THE development of rapid-transit facilities in large cities during the last ten or fifteen years has brought about many far-reaching changes in habits of life. Conspicuous among these are the building up of suburban communities, the cheapening of transportation to suit the pocketbook of the average citizen, the encouragement of the traveling habit, and the concentration of business in the modern office building. The telephone has had its share in revolutionizing commercial methods, as well as the subway, elevated road, and trolley car; but it is fair to charge the electric railway with the greater part of this centralization, which has found expression in the grouping of widely scattered business interests under the roof of the "sky scraper."

It is not many years since a four-story building was looked upon as a mighty triumph of engineering and architectural skill, daring to the degree of fairly tempting Providence in its defiance of established traditions. To-day a twenty-five or thirty-story structure rears its majestic pile two or three hundred feet above the city sidewalk, attracting little attention except from the rural visitor to the metropolis. The letting of a contract for a modern office building awakens little interest on the score of novelty, outside the professional and business circles directly concerned. The climbing of three or four dingy flights of stairs used to be accepted as one of the essentials of occupying "high" buildings, but nowadays even the tenant of the second-story office thinks himself hardly used if the elevator system shuts down for a single half-hour.

The modern high-speed elevator is a necessary product of increased facilities in rapid transit on the level, and of the rise of the office building. As a special case of the railway, it deserves wider interest on the part of engineers than it has yet obtained. Fortunately for the safety of the public at large, the legal restrictions which hedge about elevator practice in most cities are always tending toward the elimination of danger. Although the best types of elevators are among the safest vehicles of travel known to man, there still remains much to be done by architects and engineers in the way of looking into the merits and defects of different systems with a view to specifying the apparatus best adapted to the conditions in each new building.

At the present time, it is generally well recognised that the requirements of elevator service are much more severe than those of railway operation. The elevator must meet very severe conditions in acceleration and retardation, running upon a 100 per cent. grade in almost continuous service for long periods of time. In high-speed office-building practice, a car weighing perhaps 3,000 pounds may have to be accelerated from standstill to a speed of 800 feet per minute in a little over a second and a half, and this without discomfort to the passengers. Any such acceleration upon an ordinary railroad track—5.5 miles per hour per second—would be practically impossible without throwing the passengers into a heap upon the floor of the car. Even 3 miles per hour per second is more than can be comfortably sustained in elevated or surface railway service. Such accelerations call for large power capacity in the motor, steam, or hydraulic plant which operates the elevator system of a modern building. The power fluctuations are perhaps more violent in elevator service than in any other application of electric motors. The effect of a shut-down in business hours proves to be a great inconvenience to all the tenants of a large building, and there is no repair shop or car house for an elevator to run into when it is disabled, as on a street or elevated railway. Fortunately, although the service requirements are severe, there is present an opportunity for constant inspection and supervision not found in transportation upon the level; the pathway of the elevator is never blocked by teams, pedestrians, and other cars, and collisions between cars of course never take place. So rugged are the best modern designs of elevator equipment that beyond daily cleaning and oiling the machinery often runs for weeks and months without the need of repairs.

Passenger elevator speeds have been classed as high, covering from 350 to 800 feet per minute; medium, covering from 150 to 350 feet per minute; and low, covering from zero up to 150 feet. Freight elevators rarely exceed 350 feet per minute, as the cost of high-speed operation is out of all proportion to the time gained in handling merchandise, just as on a steam railway it pays to move the freight traffic at a slower rate than the passenger. When it is necessary to handle light freight at high speed, it can best be done during hours when general business is slack upon the passenger-elevator equipment.

The choice of elevators for a given installation is a very broad question, involving the careful consideration of many factors. Among these, quoting P. R. Moses, are the class of travel, distance between floors, available space, cost of labor and power, the heating system, probable relation of average to maximum load, continuity of service, and legal restrictions. Limited space in a building means that the up-and-down traffic must be handled by a few cars operating at high velocities, with all the added expense of heavy power consumption and skilled attendance to be balanced against the cost of putting in additional elevators. Here is where the need of expert engineering advice comes in. The financial problems bearing upon the elevator system profoundly affect the economic operation of the whole building, and it is a great mistake to decide off-hand upon the type of equipment to be used, or to put in a certain system on the score of personal influence without first making a careful study of the probable requirements of the new building and the operating experience obtained with different system in older structures. Too often a large amount of money is spent upon ornamental features of buildings, to the detriment of the elevator system and the rest of its mechanical and electrical plant. This condition of affairs is rapidly adjusting itself, however, to the demand of tenants for the best equipment, so that the rental power of a new building depends very much upon the convenience, safety, and reliability of its lighting and power service.

In comparing the relative merits of hydraulic and electric elevators many points must be borne in mind. The very general availability of electric current supplied from a central station makes it possible to employ this means of power to drive elevators where no other source of power is readily available. Advocates of the hydraulic machine claim that for light loads and comparatively slow speeds, calling for not too large a horse power in machinery, the simple motor-driven elevator is very satisfactory and also economical, but when speeds of 350 to 800 feet per minute are reached, the heavy loads and necessary rapid acceleration and retardation demanded by modern office-building service involve serious complication in the controlling machinery. It is not my purpose to favor either type to the exclusion of the other, but to point out some of the striking features of each class which must be taken into account in deciding upon specific installations.

In passing, mention may be made of the fact that steam-engine-driven passenger elevators have been built and successfully operated at speeds as high as 400 feet per minute, and that these machines often fill a useful place in situations where electric current is not readily available. For freight service the steam hoist has long been favored.

but no steam-driven elevator machinery can boast upon the score of economy, and for this reason electric or hydraulic hoists are coming more and more to supersede the steam-driven elevator.

Purely electric elevators are now almost entirely of the drum type, driven by a motor through a single or double worm gear. Seven or eight years ago the screw type of electric elevator commanded great attention in the engineering world, and a large number of installations of this type were made in new office buildings. The mechanical and electrical features of this type were of marvellous ingenuity, and the safety of the apparatus was unquestioned. A motor was direct connected to a screw shaft which carried sets of multiplying sheaves along the shaft upon a ball-bearing nut; the limit of travel was absolute and fixed; the controlling switches and rheostats were operated by a beautifully designed differentially wound pilot motor; the elevator came to a stop the moment the operator's hand left the switch in the car; the elevator was raised by power and lowered by gravity—the motors acting as generators and returning power to the line, braking the descent; and the comfort of the passengers was notable. Unfortunately, the equipment was very complicated; depreciation was high—over 12½ per cent. in a Massachusetts office building known to me; the starting currents were so prodigious as to flicker the lights all over the building to a degree that demanded the installation of an expensive storage-battery booster, and controlling apparatus to take up the terrific current fluctuations; and so, in spite of its many admirable features, this type went to the wall, and if I am correctly informed, is no longer manufactured. For a building but a few stories in height, where the cost of electric power is low, and very high speed is not necessary in handling a heavy traffic, the simple worm-driven electric machine has an almost impregnable field. "The worm-gear drum elevator is not fitted for the heaviest, fastest, and longest travel service of to-day, however, as its movement is endless in its character, and cannot have double or triple ropes on the drum on account of space limitations, and the impossibility of equalizing the work on the machine." Buildings but a few stories in height do not require as high-speed elevator service as taller structures, and for this reason the purely electric elevator has enjoyed great popularity in the far Western States, where very high office buildings are less common than in cities like New York and Chicago.

Safety is the prime requisite in every kind of elevator service. Danger to life must be avoided at the sacrifice of every other advantage. In no case is this more true than in residences, hospitals, and those apartment houses which dispense with the services of an elevator attendant. To meet the requirements of this service, electric elevators are now on the market in which the control and operation is reduced to the simplest conceivable terms, so that accidents cannot happen through the ignorance or carelessness of women and children. In this system a passenger desiring to use the elevator presses a button placed near the elevator shaft, and the car, if not in use, immediately travels to that floor and stops automatically. When the car has come to rest at that floor, the door can be opened. The passenger then enters the car and closes the door. Unless the door is tightly closed the car will not leave that floor. Inside the car is a series of push buttons, numbered to correspond with the various floors. The passenger pushes the proper button, and the car proceeds to the desired landing and stops automatically. Not until the passenger has left the car and closed the door can the elevator be controlled from any other floor. Should the passenger desire, for any reason, to stop the car at any point of its travel, he can do so instantly by merely pushing the safety button with which the car is provided. This type of elevator is so easily and safely operated that any member of a household can be trusted to control it.

An important advantage in certain types of electric elevators is found in the ease with which the driving apparatus may be installed at the top of the hatchway, where ordinarily the overhead sheaves would be placed. Much valuable basement space may be saved in this way. Then, too, the electric elevator motor usually takes power in proportion to its load, whereas all ordinary forms of hydraulic machine require full power for all loads, whether minimum or maximum. Efficient counterbalancing is very difficult with the hydraulic elevator; there is no return of power on the down trip to assist other elevators in ascending, and the power-generating plant of the hydraulic elevator must preferably be independent of the lighting plant, which increases the cost, adds complications to the arrangement of apparatus, and reduces the fuel efficiency. Then, too, the ordinary pumping plant is wasteful of fuel, while the more efficient types are so expensive as not to be justified except in very large plants. This last point is somewhat modified in the case of a steam-pumping plant in which the exhaust steam is utilized for heating purposes, and as far as actual cost of running is concerned, where a steam boiler is maintained for heating, hydraulic elevators run by a steam pumping plant are probably as economical as any system which can be named. As for the necessity of maintaining a separate plant, the requirements of elevator service are so severe that it is very doubtful in the case of electric elevators whether they should be run in connection with any electric-lighting system, the violent fluctuations being detrimental to the steadiness of the incandescent lamps. If storage batteries are used to take up the effect of these sudden demands, the additional first cost and subsequent maintenance charges are very heavy.

The relative cost of running the two types of machines varies with local conditions. Where the quantity of water to be pumped is sufficient to warrant high-duty pumping engines built with Corliss valve gear, the cost of pumping the water is brought down so low as to make the cost of running less than current can possibly be supplied for; but where ordinary duplex pumps are used and electric current can be supplied very cheaply, the electric cost generally runs lower. An interesting point which makes for economy in the operation of electrically controlled elevators of the best design is the iron-clad reinforcement of the magnetic circuits of the solenoid switches.

An important feature of hydraulic elevators is found in the pressure tank, which supplies water under a pressure varying from 150 to 800 pounds per square inch to the cylinder or plunger which operates the car. Generally, in types which adopt the higher pressure, great economy in space is secured, but practically all forms of hydraulic elevator with which I am acquainted—with the exception of the plunger type—operate the car through the medium of wire ropes connected with a piston operating in a cylinder under heavy pressure. The motive power which shall be chosen for pumping the water into the pressure tank may be steam, electricity, or gas, depending upon the conditions peculiar to each installation. The pressure tank relieves the system of the severe fluctuations induced by the quick acceleration against gravity encountered in the starting of the car. The piping must be of extra heavy construction to carry safely pressures as high as 600 to 800 pounds per square inch.

The elevator problem is not so much the movement of heavy loads at high speeds, but is rather a problem of control, i. e., the rapid starting and stopping of these loads without unpleasant sensations to the passengers. A carefully graduated hydraulic valve controls the flow of water to a nicety. In the case of stopping an electric elevator (and it is the stopping of any elevator that offers more complications than the starting) it is practically a question of shutting off all at once and controlling the further movement of the car by electric brakes. This introduces complications into the machinery, which requires careful adjustment and is subject to frequent derangement. In the case of the hydraulic elevator, on the other hand, the valves can be adjusted once for all and nothing whatever can occur to derange the adjustment, so that in these respects hydraulic machines are characterized by a simplicity and reliability which is absent in electric elevators. It must not be forgotten, however, that the maintenance problem of even the simplest forms of hydraulic elevator takes into account the auxiliary apparatus of the pumping system, which includes a number of valves, pipes, pump parts, and some form of driving machine. In large plants especially, it is often more convenient to place the pressure tank in the attic, or upon the roof in climates where the water will not be exposed to freezing weather.

Within the past year or two the plunger type of hydraulic elevator has come to the front for high-speed office-building service. It consists of a cylinder set vertically in the ground directly under the car, and of a length equal to the run of the elevator. In this cylinder works a plunger of the same length, carrying the car on its top. The plunger is made of steel tubing of suitable size to raise the required load with the available water pressure, the diameter ranging usually from 4½ to 8½ inches. The cylinder is built up in sections of a steel pipe one or two inches greater in diameter than the plunger, and is fitted with a stuffing box at the top through which the plunger runs. Water is admitted to and discharged from the top, the annular space around the plunger furnishing a passageway. The water supply is governed by a three-way valve, which is in turn operated by a pilot valve connected with the car lever. The water pressure commonly used varies from 140 to 200 pounds per square inch.

Several points in regard to this type of elevator are of special interest. It is absolutely safe from falling, as the car is always supported from beneath, and not suspended from above by ropes. The mechanism of the elevator proper is simple, with little to wear except the packings and guide shoes, which are easily renewed. The power is exerted directly, securing high efficiency and freedom from vibration. Valves entirely independent of the main controlling valve are provided to bring the car to a gradual stop at each end of its travel. When the run of the car exceeds 25 feet, a counterbalance is generally used. The plunger always rests upon a column of water which can escape only as it is driven out of the cylinder through comparatively small openings, and further protection against accident is found in the fact that the steel plunger would bend to the side of the well room without being put under dangerous stress. The car cannot be made to shoot up to the top of the well room, and it cannot attain a downward speed that is unsafe because of a special throttle valve which is introduced into the exhaust pipe. There are no machine parts or pipe connections below the ground; the cylinder is well protected, and has been found to be long lived in at least 20-years' experience with slow-speed plunger-type elevators. The economy of space is also noteworthy. Owing to the fact that a cylinder of equal length to the car travel has to be sunk in the ground, the nature of the soil has an important bearing upon the cost of installation.

Although brakes are in common use upon electric elevators, they have never been successfully employed upon hydraulic machines except as emergency appliances. The problem with long-run elevators is to stop them within a reasonable distance, which may be assumed to be a little less than the distance between the floors of a building—say 8 to 10 feet—a limitation that is imposed in part by the signal service. An upward-moving plunger elevator depends upon the action of gravity alone to bring the car to rest. The distance within which an elevator can be stopped depends upon the relative amount of counterweight carried and not upon the absolute weight of either car or counterweight. In practice it is found generally advisable to limit the amount of counterweight to about 75 per cent. of the combined weight of car and plunger, for however nicely the valve is graduated it is almost impossible that the elevator itself should not receive some accelerative effect from the water admitted during the closing of the valve.

The best elevator system for adoption is that which is safest, and in so far as is consistent with the conditions, most comfortable to passengers, quick and easy in operation. As in most engineering problems, the solution must be in the nature of a compromise. A point to be borne in mind is the elevator load factor of the building, which rarely exceeds 50 or 60 per cent., and generally runs at half of that in the busiest office structures. High speed and economy are more or less opposed to one another, so that in figuring the cost of operation it is well to realize that a slight reduction in velocity cuts down expenses very materially. It is most essential to submit all known operating conditions to bidders, and to go over the entire problems of transportation within the building at hand as thoroughly as a reliable consulting engineer advises. When the system begins to operate, data should be regularly kept to show the running expenses of each elevator, depreciation, repairs, etc. Above all else, safety demands the closest inspection, and must outweigh all other advantages in the choice of the system to be used. It is probable that the speeds of the future will not be greatly in excess of those of the present, and that as the years go by, elevator accidents will grow farther and farther apart, thanks to the interest of the engineering profession in this important mechanism of transportation.

A DEVELOPMENT OF RECENT MACHINE-SHOP PROCESSES.

THE PRODUCTION OF INTERCHANGEABLE WORK IN THE GENERAL SHOP.

By Wm. M. Barr.

MACHINE shops are divided into two general classes—shops in which things are made, and shops in which things are manufactured. Both are necessary to the proper development of machine industries; each has a field peculiarly its own, and each may be of the highest order in equipment, utility, and commercial importance.

A marine-engine shop is a good example of a shop in which things are made. It rarely happens that marine engines are duplicated. The design, materials, and workmanship must be of the best. Many of the parts require to be interchangeable, and they must be made so without the employment of jigs or other permanent fixtures which might be rendered useless upon the completion of the work in hand. Marine-engine work is therefore taken, in the following pages, as the source of a few examples showing how interchangeable work may be produced with the ordinary general equipment of a "non-manufacturing" shop.

Duplicating should be carried to the utmost limit, as it greatly simplifies work in the drawing room, pattern shop, tool room, and the machine shop. Patterns for special work (unlike those for standard work, which demand the best of material and workmanship) may be made in the cheapest way, from ordinary lumber costing less than half as much as standard pattern lumber. The parts may be nailed together, the fillets made with putty, and the whole given one or two coats of black varnish to prevent the sand from sticking to the pattern. It is common in patterns of this kind to allow a little extra thickness of metal where the parts are to be fitted. If core boxes are required for such patterns, they can be made in the same temporary manner as the main pattern. Both pattern and core-box material can be afterwards used for boxing or other rough use about the works. A sweep can be employed to advantage in many cases, the necessary projections being introduced into and attached to the mould, and the pattern being withdrawn when the mould is ready for drying. Swept-up work may also be done by straight edges as well as by curved formers, depending upon the design in hand. The interior core is usually built up in brick covered with loam, and inserted in the mould in guides provided by the main sweep.

Steel castings can be made to take the place of forgings in many cases at a very considerable reduction in cost. The greatest care must be exercised in designing and proportioning steel castings to avoid thick parts and thin connections. The thin parts will cool much more rapidly than the thick parts, and are liable to open up a seam along the line of the light web or projection.

A shop of this kind will include as a necessary part of its equipment, massive lathes, planers, vertical and horizontal boring machines, slotting and shaping machines, and, in addition, a large cast-iron floor plate upon which the work is fastened to be operated upon by portable facing, slotting, milling, boring, drilling and tapping machines, as may be required. These will be independently driven by electric motors attached to each machine. Portable drilling machines driven by an endless cord can be used to good advantage on heavy castings even though the works be fitted with large radial drilling machines.

A well equipped tool room is as essential to economy here as in a highly organized manufacturing establishment. A complete set of standard gauges, as well as drills, taps, and reamers up to 3 inches diameter will be provided, and special ones, as may be required, up to 4 inches and sometimes larger. Steel measuring rods will be found much more satisfactory than the use of a steel tape for all length below 8 feet; these rods may be 5/16 to 5/8-inch square, depending upon the length, the ends tapered, hardened, and ground to exact length; these can be used for transferring dimensions by calipers, as well as by direct use. Plugs and rings above 3-inches diameter may be made of cast iron and insure all the accuracy needed in occasional work.

There are certain standards which should be adopted in every manufacturing establishment and used in all cases where they are applicable to the work in hand. This is especially true in the case of screw threads, which should be of the United States standard, or correspond with the accepted standard for pipes. Special screws necessitate special taps, and are otherwise objectionable. Flanges should be made to conform to those adopted by the several engineering societies, or, at least, they should be uniform throughout the establishment.

Simple cast-iron drilling templets, even when made of considerable size, will ordinarily pay for the making. In general, but one cast-steel bushing is needed, being transferred from hole to hole as required, the inner diameter conforming to a suitable diameter of drill selected for a tap, reamer, or the clearance for through-going bolt. Through-going bolts with head and nut should be used wherever practicable, because the drilling is of the simplest character, and the bolts and nuts can be purchased at prices lower than in the case of tap bolts or standing bolts. Tapping into cast iron should not be resorted to if the bolts are to be frequently removed, inasmuch as cast iron is a brittle material, and the frequent removal of a bolt will soon impair the strength of the thread in the casting. A much better plan, but one which is not always practicable, is to insert standing bolts.

The preparation of general and detail drawings is essentially the same, whatever the type of shop in which the work is to be executed; but the pattern maker, in order to meet the uncertainties of shrinkage, or the twisting of a casting in cooling, makes certain allowances for finishing, which are greatly in excess of those given for standard work in a manufacturing establishment. The extra amount of material to be removed is but a small percentage of the total weight; the strength and rigidity of the machine tools employed will enable this extra metal to be removed with little loss of time over that necessary to do the work in any case. The important detail thus secured is that the finished parts exactly correspond to the dimensions given in the general design and detail drawings.

The order of precedence in which the main castings are carried through the works is not a vital one, but, in general, the more important and difficult work, such as the cylinders, is begun first, to be followed by the bed plate, framing, cylinder linings, valves, and smaller parts. The larger castings must be accurately measured, to ascertain not only whether they will finish to the given dimensions, but whether the center lines of the assembled work will conform to those of the approved design. If not, a change must be made somewhere to insure this important detail.

Bed plates made of steel castings require a more liberal allowance for finishing than is usual for cast iron; the matter of shrinkage and distortion in cooling is also more uncertain. Consequently the allowance for finishing and facing for the crank shaft brasses and caps must be generous, and a liberal allowance be made also for planing down the spottings for the supporting frames and columns. This applies also to frames made of steel castings, which vary considerably even when cast from the same pattern, especially when of the inverted Y design.

After fitting the caps in place, the bed plate will be bored for the main bearings. Care must be exercised that the planed spottings on the top of the bed plate, to which the engine frames are bolted, are parallel to the axial line of the bearings, and that the end spottings where the bed plates bolt together are at right angles to this line; the first requirement may be secured by parallel bars, the latter by a tram inserted in a slot in the main boring bar. If the casting is not too large to be fitted on a 10-foot planing machine, all necessary horizontal and vertical planing can be done there, as well as the locating of all center lines upon the casting, which will then be marked to correspond to the centers of the machine itself. These center lines upon the framing are to be utilized afterwards when the several castings are assembled on the erecting floor, the center markings being adjusted axially with reference to the main bearings, and transversely by locating the centers of the cylinders by these points of intersection.

Crank shafts for medium and large triple-expansion engines are commonly made duplicates of each other, with coupling discs forged on. These crank shafts are forged from open-hearth steel ingots and turned to within an ⅛ inch of the finished diameter at the forge; the final finishing is accomplished at the works, to dimensions corresponding to certain steel bars with ends hardened and ground to such lengths as are called for in the drawings. These bars, having been numbered and registered, are returned to the tool room after the completion of the work requiring them, and form a part of the tool-room equipment. If a shaft is required to be hollow (and nearly all specifications call for such shafts), it is usually forged so by hydraulic pressure from a selected ingot through which an axial hole has been drilled, and in which is inserted a mandrel smaller than the finished dimensions, the shaft being afterwards bored with a drill head similar to that employed in heavy ordnance. The diameter of the hole through the crank pin or through the shaft is commonly one-half the diameter of the latter. Such a shaft combines maximum strength with minimum weight; the resistance to torsion is reduced by about 2 per cent., while the weight is reduced some 25 per cent.

Coupling discs for three-throw crank shafts should be drilled through a cast-iron templet bushed with steel. The three crank shafts must be in the same axial line, and, when bolted together, the cranks will be at angles of 120 degrees to one another; starting with the high-pressure crank, the intermediate crank will follow, and the low-pressure crank will follow the intermediate one. It is necessary then that the templet accurately represent these angles. One way of accomplishing this is to mark permanently the center line of the crank pin on the crank webs, and carry this center line to the coupling discs and make a permanent mark upon each for reference. The edge of the templet having been accurately spaced at 120 degrees, no difficulty is had in drilling the bolt holes in the coupling discs, but the final reaming may be reserved until the crank shafts are put in place in the bed plate.

The engine frames can ordinarily be fitted on the ends in a large planer. After planing, the top and bottom center lines can be located and the bolt holes laid off; as all three of these are probably alike, it will be found economical to make a drilling templet with removable bushing, the same templet being used for the frames and for the main bed plate by a mere change of bushings. Where the facings occur for the reversing gear, spottings will be provided, which will be planed with reference to the center line of the cylinder.

Cylinder casings usually include the casing for the piston valve. The external facing and internal boring for the reception of the working cylinder linings can be done on a vertical boring mill; usually the larger cylinders will require that the valve casing be bored on another machine. It is desirable always that cylinders be bored as they are to be used—that is, vertical cylinders are to be bored vertically.

Pistons made of cast steel require careful measurements to see that no unusual distortion has occurred and that no lumps are present on the surface which will make contact with either head. If sufficient allowance has been made, it is well if a slight chip be taken off both sides of the piston; this can be done on a vertical boring mill before the final cuts are taken on the periphery for the insertion of the packing rings.

The piston rods will probably be made hollow and will all be of the same diameter and of high-grade forged steel; the end entering the piston will have a taper joint with a collar underneath and a hexagon nut above. This is a somewhat troublesome piece of fitting, and the cost of making a cast-iron plug and ring by which this fitting may be expedited will be well earned before completion of the work. The fitting into the cross-head being similar in construction will serve to further divide the cost. The piston rods will be finally ground smooth and to the diameter given. Metallic packing will be supplied by the maker selected.

Connecting rods will be of high-grade forged steel and made hollow. The upper end will be forked to span the cross-head, the lower end adapted to receive the brasses of the usual marine type. These rods will all be alike and are costly pieces to make. The tools required include lathe, planer, slotting machine, and boring machine. There is no special difficulty in the making; the work must be properly laid out in the beginning, the center lines carefully observed and the given outlines carefully followed.

The valve gear, including the eccentric rods, main links, link blocks, valve-stem cross-heads, reversing shafts, and connections, are all of forged steel and present no special difficulties. Sheet-steel templet or gauges can be used with profit in most cases, and will insure accurate duplication of parts and be found useful in future repairs.

Screw propellers will have each blade bolted to the boss fitted to the propeller shaft. The end of the shaft is turned to a given taper and the boss fitted to it. A gauge of corresponding taper should be made, so that both of the propeller shafts in the case of twin screws and their bosses shall be exactly alike. The propeller blades will fit into taper recesses in the boss and be secured by tap bolts. Templets should be made for both the central boss and the propeller blade. These may be made of sheet steel or a thin iron casting fitted to the dimensions given in the drawing.

By making the main shaft in standard uniform lengths, this portion of the work may be made standard, and all the difference in various jobs thrown into the tail shaft. Two spare pieces, one tail shaft and one standard length, will then enable a break in any portion to be repaired at any port, without demanding expensive shop work.

It is unnecessary to enlarge further upon this subject; enough has been suggested to indicate that a modern and progressive shop can, with a modern expenditure for a few simple templets, gauges, and measuring devices, build heavy work, strictly interchangeable, at no appreciable increase in shop cost.

EDITORIAL COMMENT

THE past month has been fertile in engineering and scientific congresses, following the usual course in association with international expositions, and we have had congresses of electricity, of civil engineering, and indeed of the whole world of arts and science, with a flood of papers, some of which we have noticed at length elsewhere.

Speaking from experience in such gatherings, it has appeared to be a question whether the occasion of an international exposition is the most favorable opportunity for gatherings of scientific and professional men, if the ultimate value of the communications and reports to the technical and scientific world is included, and the same features are to be considered in this connection as exist for the exhibitions themselves.

An international exposition is a great show of the work of the world at the period at which it is made, and it passes into the record as a picture of the state of the arts and sciences at a definite stage of the world's progress. The fact that such displays attract a number of men of science and industry at a given time has naturally led to the organization of such bodies of visitors into gatherings for the interchange of opinion; but experience has shown that just as the great exhibition has developed into a sort of overgrown country fair, with a continually increasing tendency for the preponderance of the element of amusement, so the international congress has proved to be a plan for getting a great number of notable men together for the principal object of effecting their aggregation, the thoughtful discussion of existing scientific problems becoming next to impossible under such conditions.

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IT has been believed by many that the international exposition has outgrown its usefulness with its increase in size, and that the natural result will be a breaking apart by its own weight, or rather bulk, so that hereafter we shall have smaller specialized exhibitions, devoted to definite portions of science and industry. In connection with these there may well be held gatherings of earnest men, devoted to the same general line of work, and prepared, not for a species of scientific spree, so to speak, but rather for a carefully prepared discussion of a certain limited number of current questions, divested of commercial influences, and conducted for the true advancement of the department of applied science under consideration, with the special object of mapping out the lines of future attack upon the secrets of Nature and the forces of the universe.

* * *

THE eve of an election is a time fraught with possibilities of the unexpected, but at the moment of writing the signs point strongly to the continuance of the present administration. This is the situation which has been discounted, apparently, in business and financial circles—discounted so largely that some reaction may be normally expected even if the results confirm the forecast. The quiet of the campaign and the steady increase of tone in the commercial world doubtless are due chiefly to the general conviction that both tickets stand for conservative administration and policy, and that in no event would business interests be called upon to adjust themselves to any sudden or violent change. May the victorious party not misconstrue or overestimate the meaning of their victory! There are some grave economic questions demanding adjustment, and growing more and more insistent in the demand. The fact that they have not been made party issues should make it easier for both parties to agree, under the new administration, upon a method of determining and meeting the needs of the country in the matter particularly of the tariff—to discuss it as a matter of policy, and not of politics. May whichever party wins see that the election does not settle these great questions, but only place upon the winners the obligation for their wise settlement!

* * *

THE unequivocal language of the Government commission, in their report on the Slocum disaster, and the prompt removal of the officials held chiefly accountable, does a good deal to lessen the distrust into which the steamboat inspection service has fallen as a result of the incredible disclosures recently made. Until public attention was centered upon the actual conditions of the law and its administration, by the inquiries following the burning of the excursion steamer, there was a general feeling that (outside, perhaps, of the Custom House) the Federal arm was strong and the Federal eye watchful to protect the individual citizen. There was both anger and terror in the sudden discovery that bureau officials, charged with the most important and sacred duties toward their fellow countrymen, were, if not corrupt, at all events so indifferent, incompetent and immersed in senseless routine that their office was a contemptible mockery and their "work" a hideous farce. An awful price was paid for the exposure, but there is no uncertainty about the correction administered by the President. The ex-supervising inspector who was quoted, just after the disaster, as angrily exclaiming that his office was "not concerned with the wants of the public," should by this time be a good deal enlightened on the status of a Government official, and his record perhaps be helpfully warning to office-holders of the same stamp for some time to come.

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IN connection with the subject of the revision of the present lax method of conducting the inspection of safety appliances on steamboats, the matter of making such inspection really effective may well demand the attention of the engineer, and the magnitude of the work is such that every possible appliance to render the work capable of rapid and successful conduct should be used. The discovery that certain so-called life preservers have been placed on the market with pieces of iron enclosed in the corks has brought up the point that the only form of inspection which could reveal such dangers would include the destruction of the article inspected.

This, however, is wholly unnecessary, since the use of the X-ray apparatus would reveal the presence of the iron most distinctly. It is suggested that every life preserver should undergo the test of X-ray examination, as well as the test both for size and for weight. The former would reveal the presence of any foreign substance, while the combination of a determinate size and weight limit would involve the question of specific gravity, and render deception trebly difficult.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE TRANSMISSION OF ELECTRICAL ENERGY.

PRACTICAL QUESTIONS INVOLVED IN THE LONG-DISTANCE TRANSMISSION OF ELECTRICAL ENERGY AT HIGH VOLTAGES.

International Electrical Congress.

AMONG the subjects considered and discussed at the electrical congress recently held at St. Louis, the question of the transmission of electrical energy held an important position. The papers presented included treatments of the questions of construction, insulation, general design, and operation, including practical experience with such important lines as are found in southern California, where more than 40,000 kilowatts are transmitted from 150 to 200 miles at pressures of 40,000 to 60,000 volts.

In such lines naturally the principal points considered are connected with the insulation of the line at such high pressures, and among the papers dealing especially with insulation may be mentioned those of Professor Harris J. Ryan, Mr. M. H. Gerry, Jr., and M. E. Jona. The subject of long-spans was treated by Mr. Francis O. Blackwell, while the general details of high-tension long-distance transmission were treated by Messrs. Baum, Perrine, Hancock, Kelly, and Bunker.

The important elements involved in the design of such transmission lines may be considered as due to the length of the line, and to the voltage to be used, although these also bear certain relations to each other. Considering first matters relating to the distance over which the energy is to be transmitted, the important matters are those relating to the strength of the material of which the conductor is made, its conductivity, and the manner in which it can best be supported. In this connection Mr. Blackwell notes the difference between a long-distance transmission and one of moderate length.

"It is obvious that the longer a line the more reliable and substantial it must be. A plant transmitting power five miles might be shut down three or four times a year by line troubles without seriously interfering with its service. If, however, there were 500 miles of circuits instead of five, and the same number of accidents per mile occurred, the plant would be shut down every day, and the power would be absolutely valueless. Moreover, the longer the transmission line the more difficult it is to locate and correct a fault. On a five-mile line repairs might be made in an hour or two, while on a 500-mile system it would probably take a day to find the place and get the plant in operation again.

"Existing wooden pole lines have given good results and electric power has proved successful even under adverse conditions and justified the investment of greater capital in larger plants and longer power transmissions.

"The same reasons which have led the railroads to replace their wooden bridges with steel structures will ultimately cause power transmission engineers to substitute steel for wood in all important transmission enterprises. The advantages of a steel-tower construction are that it is fireproof, durable and readily admits of structures of a size and strength impracticable with wood. With higher and stronger supports for the power circuits longer spans can be employed and the number of points of support correspondingly reduced. This fewer number of parts much simplifies the transmission system, both in construction and in operation, and permits of more expensive and reliable designs being used. The wires may be placed much farthtr apart, thus obviating the principal cause of trouble—short-circuits. The insulators may also be larger and better, both electrically and mechanically, and every part of the system can be laid out in advance, the strains calculated and the structures designed with ample factors of safety.

"The length of span to use is the most difficult question and the one into which the most factors enter. The calculation of long spans is primarily a suspension bridge problem in which all the mechanical stresses must be fully investigated."

So far as the strength of the conductor is concerned, Mr. Blackwell compares conductors of copper, aluminum, iron, and steel, and discusses the influence of elasticity, temperature, weather, span, and sag, giving curves from which the relative merits of the materials may be compared.

In considering the methods of supporting line conductors Dr. Perrine agrees with Mr. Blackwell in recommending metallic towers as substitutes for wooden poles, spans of 500 feet being considered as practicable, and this plan is also endorsed by Messrs. Kelly and Bunker.

Next to the question of supports for the line, the matter of insulation must be considered, and, with the high voltages now in use and proposed, this becomes a most important element in success. It is admitted that the experience acquired with low-pressure installations is of small avail for high voltages, and Dr. Ryan treats the problem from the viewpoint of the physicist, and deduces formulas from the elements of modern electrical science for determining the electric strains and the methods of meeting them. The practical difficulties in the matter of insulation are well discussed by Messrs. Kelly and Bunker.

"The selection of the line-insulators depends entirely upon the voltage, mechanical strength required, and the localities through which the line passes, more particularly the latter, as lines have been operated at 45,000 volts with two or three types and sizes of insulators in as many different sections. The design of the insulators should be such as to give the smallest amount of still-air space and the greatest accessibility for wiping by hand. Fog occurring at the same time or intermittent with soil, factory, or car-dust is one of the surest causes of trouble, and reduces probably, to the greatest extent, the effective commercial size and value of insulators. Upon examining a large number of insulators which had to be removed, it was found that the dust, with which they were coated, was thickest in the still-air spaces, and was as thick on the vertical as on the horizontal surfaces. It has been found that where insulators were subjected to fogs or dust alone (except sea-fog), the same number of troubles did not occur as when both appeared together. Where insulators are covered with dust, parts of each year, it has been necessary to shut down the circuit from one to three times during the dust season to wipe them clean. This can be done while in position and without disturbing them unless they are found to be damaged.

"The fact that insulators are successfully tested for high voltage before they are put up does not necessarily prove that they will not cause any trouble when on the line. Insulators which were tested for 120,000 volts water test for one minute have given trouble in less than a month after being placed on a 40,000-volt line. Other types which had stood 40,000 volts water test for five minutes have been known to be unsatisfactory for 13,000-volt city (overhead) service, though this would not hold in every city. The greatest value of electrical test for insulators before being used is to determine whether the various parts are homogeneous and whether they have been properly cemented together."

In addition to the maintenance of proper insulation upon the line there are certain portions of a high-pressure transmission which involve the use of insulated cables. The problems connected with the insulation of cables at high voltages were discussed in the paper of M. Jona, he deducing formulas for the proportion of lead-covered cables, with rubber insulation, as well as with paper and with gutta-percha. So far as the distance between the lines themselves is concerned, this is usually determined from the maximum voltage to be expected, the usual rule being that the distance between wires, in inches, equals one and one-half times the number of thousands of volts.

"Where the cost of erected poles is high, or the right of way expensive, two circuits per pole-line should be used, and, with good wooden construction, mechanical difficulties would limit the distance between wires to at most 60 inches, which would allow a line voltage of say 50,000 or 60,000. This distance between wires is for spans not over 150 feet to 200 feet. The size of wire is determined from the load, voltage, length of line, losses allowable, etc. Five per cent. energy loss per 50 miles with 60-cycle frequency gives a line which can be taken care of, but a smaller loss should be obtained where important lighting service is had in connection with a fluctuating load. On account of the distance and pressure, a charging current, at no load, is required of the plant, which at 60 cycles and one line 100 miles long, or 30 cycles and two lines, would require a generator as large as 2,000 kilowatts, so that, unless more than this capacity had to be delivered as load, the system would not be economical. In order to be perfectly flexible, this amount of power would have to be carried over one circuit. The wire would, therefore, be large enough for mechanical reasons, and the energy loss per insulator, or per unit length, would be negligible, except, perhaps, for voltages over 60,000."

Another matter, and that one of much difficulty, is found in the provision of satisfactory lightning arresters.

"For voltages up to 25,000, the non-arcing types of lightning arresters, either with or without series resistances, may be successfully used. Above this voltage and where large amounts of energy are available, these arresters are found to be short-lived, and up to the present time no thoroughly satisfactory arrester has been presented, which does not, when interrupting the ground circuit after a discharge, injure the insulation of the line and transformers. The horn form of lightning arrester developed in Germany has been found to operate with invariable success so far as the lightning arrester itself is concerned, but, as it is interrupting the ground circuit, it draws a large arc, and oscillations are produced on the line, which in many cases have been found to have more serious results than the discharge they were installed to remove. Condensers in parallel with the lightning arresters and ingenious arrangements of arresters and resistances have been used with some success, but none of these plans may be considered to be entirely satisfactory for the highest potentials operated from the largest generated plants."

Taking all the elements of high-pressure, long-distance, transmissions into account, the papers at the International Electrical Congress form a symposium representing the latest successful practice, together with a résumé of the theoretical lines along which further progress may be expected.

AIR IN BOILER FEED WATERS.

THE INFLUENCE OF GASES IN SOLUTION UPON THE CORROSIVE ACTION OF WATER IN STEAM BOILERS.

Jas. Alex. Smith—Victorian Institute of Engineers.

ONE of the important considerations in boiler operation is the care necessary to prevent corrosion, and this has well been called the most insidious enemy of the steam boiler. Corrosion has been attributed mainly to acids or other impurities of a similar nature in the feed water, and much has been written concerning the precautions to be taken with the acid waters from coal mines and similar sources. Experience has shown, however, that the presence of gases in the water may lead to serious corrosion, and in a paper presented before the Victorian Institute of Engineers, at Melbourne, Australia, by Mr. James Alex. Smith, this phase of the question is discussed in the light of recent experiments.

It is well known that moist iron will become corroded in the presence of air, and in nearly all cases there is an appreciable amount of air contained in boiler feed water, but this fact has not always been considered in connection with corrosion. Air in the feed water means air in the steam, and it has long been appreciated that the presence of air in the steam will affect the vacuum in the condenser, so that sufficient air-pump capacity must be provided to keep the condenser clear. Mr. Smith considers the effect of the absorbed air in the water with respect to the boiler itself, and brings out some interesting facts.

Ordinary air contains about 79 per cent. of nitrogen and 21 per cent. of oxygen, neglecting the carbonic acid and rarer gases, and is a mechanical mixture and not a chemical combination. The oxygen and nitrogen, however, are not absorbed in the same proportion by water, and according to the investigations of Bunsen, it appears that the gases absorbed by pure water consist of oxygen and nitrogen mechanically mixed in the ratio of about 35 per cent. of oxygen and 65 per cent. nitrogen, there being thus a much greater proportion of oxygen in the water than exists in the air. Similar results have been obtained from the investigations of Winkler and of the author, the relative proportions of oxygen and nitrogen absorbed by the water being also found to vary to a certain extent with the temperature.

"Water is thus selective in its action, and under no conditions of pressure or temperature can air, except as bubbles, mechanically entrained, and rapidly separating out, be absorbed. The gaseous mixture occupying the inter-molecular spaces of the fluid differs from air. This is immaterial so far as vacuum is concerned; all gases, when disengaged, obey sensibly the same temperature-pressure volume law; but from the chemical point of view the case is different, the oxidizing agent is largely increased.

"Assuming the containing vessel to be of iron, then, on the principle of least work, oxidation would initially proceed by the fixation of the uncombined oxygen released from the feed, since oxygen abstracted from water implies dissociation, the evolution of free hydrogen, and the expenditure of energy.

"Ferric hydroxide is the result of the combination of oxygen with iron in the presence of water; the iron component represents 11 parts by weight of iron in combination with 48 parts of oxygen. It may be shown arithmetically that each cubic inch of oxygen at atmospheric temperature and pressure is capable of reducing 0.84 of a grain of iron to rust, or, in other words, the free oxygen found in each pound of pure, atmospherically saturated feed is potentially capable of dissolving 0.154 grain of iron, equivalent to more than 1½ grains per gallon.

"The word potentially is used advisedly. The solvent action is possible in full, given a clean and sufficiently extended metallic surface, and time; it is a function of time and surface. That complete saturation is ever approximated in practice is problematical, otherwise about 2-3 of a pound of iron would be consumed for 1,000 horse power hours.

"Known facts relating to feed pipes, economiser tubes, and those parts of boilers near the inlet, amply prove that marked oxidation may ensue when the gases are released by temperature increment, and whilst they still continue in a constricted fluid flow, in contact with relatively large bounding surfaces. Later, owing to the extreme tenuity of the gases when expelled into, and diffused through the steam spaces, and swept forward by the vapor, the bulk of the atoms never reach a corrodible surface."

When the corrosive action of the oxygen in the water is considered it will be seen that chemically pure water may not be the most desirable feed for a steam boiler. The presence of substances having an affinity for oxygen may prevent injurious action to the metal, but this depends upon the nature of the combinations. Thus, feed waters containing mineral matter might fix a portion of the free oxygen, and if the resulting salts are insoluble they will be deposited as mud or scale, and although objectionable for some reasons, will not corrode the iron. If the salts are soluble and corrosive, however, the oxidising agent will no longer be steam swept from the system, but remain to act upon the metal with which it comes in contact.

The action of the contained oxygen upon oil which may be in the steam is a matter of interest, and Mr. Smith notes some features in this connection.

"Oil in the atomised state presents, in relation to its mass, a very large superficies, but by reason of the gaseous diffusion, extreme effects need not be expected, unless the action continues and is cumulative. Something of this nature may arise when feed containing emulsified oil circulates continuously through a surface-condensing plant.

"Holde's determinations of the absorptive power of mineral cylinder oils varies from 0.1 to 0.45 cc. per gramme—the figures are greatly higher for animal and vegetable oils, or mixtures of these with mineral lubricants—therefore free oxygen in the quantities found in practice may play a not inconsiderable part in the economy of steam lubrication. Possibly the difficulty of separating the emulsified oil from hot-well waters may be traced, in part, to isolation of particles consequent upon surface induration arising from the preceding cause."

The question may arise as to the action of oxygen contained in the steam upon the surfaces of a superheater, and here an interesting fact appears. The well-known Bower-Barff process for protecting iron from corrosion by the formation of a surface coating of magnetic oxide, involves the exposure of the heated metal to a current of superheated steam, the result being the formation of the highest oxide of iron which can be produced, and hence these surfaces are protected against further corrosion. At the same time there may be a corrosion, due to the action of fatty acids, produced in consequence of the oil-oxygen combinations. It is a matter of record that before the days of mineral cylinder oils, when tallow was extensively used as a cylinder lubricant, the metal of the valve-chests and cylinders of steam engines was rapidly corroded, doubtless by the production of fatty acids produced in the course of the oxidization of the animal oils.

Mr. Smith's paper gives a tabulated résumé of his own experiments, together with a temperature-gas-emission curve, and it will undoubtedly be found a valuable contribution of a feature in steam engineering which has hitherto been given insufficient attention.

LIQUID FUEL FOR MARINE SERVICE.

TESTS CONDUCTED BY THE LIQUID-FUEL BOARD UNDER THE DIRECTION OF THE BUREAU OF STEAM ENGINEERING OF THE UNITED STATES NAVY.

Journal of the American Society of Naval Engineers.

WE have referred already in these columns to the important trials being conducted under the direction of the Bureau of Steam Engineering of the United States Navy upon the practicability of using liquid fuel for naval vessels, and the appearance of the complete report forms a fitting climax to the career of Rear Admiral Melville as Engineer-in-Chief of the navy, and Chief of the Bureau of Steam Engineering. Although the report has appeared since the accession of his successor, it represents work done during the incumbency of Admiral Melville, and the portly volume forms a most valuable contribution to the science of steam engineering. It is to be hoped that the rumors of the abandonment of the policy of publicity in the engineering work of the Bureau hereafter are unfounded, and we trust that Rear Admiral Rae will endeavor to make his Bureau of the same value to the engineering profession as his honored predecessor has done.

The report, which has been made by Commander J. R. Edwards, Lieut.-Com. W. M. Parks, and Lieut.-Com. F. H. Bailey, all of the United States Navy, is most exhaustive in its character, and is published in extensive abstract in the *Journal of the American Society of Naval Engineers,* and we give here some account of the work and the general conclusions which have been drawn.

The report is based upon a number of practical trials, the most complete of these being made by the Board itself upon a water-tube boiler arranged in the Washington navy yard in a manner reproducing as closely as possible the conditions obtaining on shipboard. To these have been added reports of the practical experience upon vessels, notably the voyage of the *Mariposa,* between San Francisco and Tahiti; the *Alameda,* between San Francisco and Honolulu, and the *Nebraskan* and the *Nevadan,* between New York and San Diego, California.

In the report are included detailed accounts of the construction and operation of the various forms of burners used, and a mass of practical experience acquired in the course of the trials.

Within the space here available but an abstract of the conclusions can be given, but the full report should be studied by every one interested in the use of liquid fuel for the generation of steam, whether afloat or ashore.

In the first place, there is no difficulty in burning oil in a uniform manner, and the necessary skill can be readily acquired by the labor available. The spraying of the oil may be very conveniently effected by steam, and for stationary plants this will probably be found the best method. On shipboard, however, the consumption of steam for spraying makes increased demands upon the evaporating plant for the supply of fresh water to the boilers, and hence compressed air is to be preferred. When the combustion is to be forced, as must undoubtedly be required on warships in emergencies, the best spraying medium is highly-heated compressed air.

The presence of water in the oil interferes materially with satisfactory combustion, and special provision should be made for the removal of the gradual accumulation of water in the bottom of the supply tanks. So far as evaporation is concerned, there is practically no difference between crude and refined oil, from 3 to 3½ barrels of oil being equivalent to a long ton of ordinary coal, while 4½ barrels of oil are required to evaporate as much water as a long ton of best Cardiff or Pocahontas coal. In addition to the advantages derived from the heating of the air it is advisable to have the oil heated, this aiding in securing uniformity of flow, while careful provision should be made for straining the oil to prevent the choking or clogging of the burners.

While it is doubtless desirable that installations for oil fuel should be designed for use with liquid firing, it is not difficult to apply the system to existing plants. The simplest furnaces show the greatest efficiency, and there is no necessity for filling up the combustion space by the construction of brick arches. In Scotch boilers there should be a simple vertical brick lining of the back combustion-chamber wall, and a lining of the front end of the furnace for about a third of its length.

Experience has shown that when oil is used as fuel in Scotch boilers the introduction of retarders in the tubes will prove beneficial, not only by preventing the products of combustion from passing too freely through the tubes, but also because of the more uniform distribution of the gases through all the tubes. Where oil is properly burned it can be regarded as a fact that the velocity of the flow of the gases is greater than where coal is used, on account of the retarding action of the soot formed in the tubes with coal firing. Retarders should therefore be used in the case of fire-tube boilers, and increased baffling in the case of water-tube boilers.

The efficiency of oil plants will be primarily dependent upon the character of the installation of fittings and auxiliaries. The form of the burner, so long as it is manufactured in accordance with certain well-known principles, and all its parts are accessible for overhauling, will play a very small part in extending the use of crude petroleum. The method and character of the installation is all-important, and therefore the work of designing and constructing such a plant should only be intrusted to those who have given careful study to the matter, and who have had extended practical experience in burning the crude product. Consumers should take especial care that they neither purchase appliances that have been untried, nor permit the installation to be effected by persons who have had but limited experience in such work.

Where crude petroleum has undergone a slight refining or distillation no ill-effects result to modern steel boilers. From the standpoint of endurance of the boiler, however, the advantage, if any, is with oil. Crude oil, however, by reason of its searching and corrosive effects, has a greater tendency than refined oil to attack the seams and tubes of modern boilers. For marine work, therefore, no crude petroleum should be used, and particularly for ships making long voyages the fuel oil should undergo some mild distillation before being placed in the tanks.

The report emphasizes the point that no

attempt should be made to use oil as auxiliary or supplementary to coal. Such an installation is certain to prove unsatisfactory, and the solution of the oil-fuel problem for naval purposes is only delayed by any attempt to inject a limited supply of oil fuel over a bed of incandescent coal. The mechanical features of the problem having been satisfactorily met, the good of the service requires that any installation attempted should depend upon oil as fuel alone and not in any combination with coal.

The most important portion of the report, however, after the entire practicability of the mechanical details of burning liquid fuel have been demonstrated, lies in the recommendations with regard to the supply. It is shown that the available supply of the world's supply of crude petroleum would not meet over 3 per cent. of the world's demand for coal and other combustibles, and hence efforts should be made to use oil fuel for special purposes only, and in particular localities.

In view of the fact that 48 per cent. of the world's output of crude petroleum is produced in the United States, and that practically the entire yield is secured from fields which are in pipe-line communication with important and strategic ports, the Board considers that a joint commission representing commercial, manufacturing, maritime, and naval interests should be authorized by Congress, whose province it would be to formulate such rules and regulations as would provide for an economical, efficient, enduring, and safe oil-fuel installation. Heretofore the oil-fuel problem has been principally investigated by various individual interests which have sought to secure information along certain lines and as a result there has not been secured that knowledge of the subject which would insure for the country at large such development of the use of crude oil for fuel as would be warranted, considering the natural advantages possessed by the United States in having at its command near great seaports so large a proportion of the world's production of the crude product. Particularly for the development of American commercial interests in the Gulf of Mexico and on the Pacific coast would the work of such a commission have an important influence in extending its prestige and power, whether viewed from a commercial, maritime, or naval standpoint.

RESPIRATION DEVICES FOR MINES.

THE ARTIFICIAL REGENERATION OF AIR FOR RESPIRATION IN LIFE-SAVING APPARATUS FOR MINING SERVICE.

Director G. A. Meyer—Glückauf.

A VARIETY of devices have been made for protecting miners and others from the suffocating effects of gas and smoke, and thus enabling rescue parties to work in an atmosphere unfit for ordinary respiration. The earliest of these employed such methods as the use of moistened filters and the like, through which the air might be drawn, and these were followed by the provision of reservoirs containing air, usually compressed to enable sufficient to be provided, the supply being conveyed to the mouth and nose of the wearer by suitable connections of elastic tubing. More recently such appliances have been greatly improved by the substitution of small reservoirs of compressed oxygen for the air supply, this greatly extending the range of time during which the apparatus can be used, and other improvements have been made in the light of experience.

A very complete series of investigations have been upon such appliances in connection with the work of the Shamrock mine, in the Dortmund mining district in Germany, and from a report of these experiments, by Mining Director G. A. Meyer, in a recent issue of *Glückauf,* we make some abstracts.

The later respiration devices, such as that known as the pneumatophor, include the idea of a continual renewal of the air used by the wearer of the apparatus, the carbonic acid emitted from the lungs being removed by some absorbing substance, while the oxygen required for the blood is replaced by a supply of the compressed gas carried in a separate vessel. The original volume of air is carried in a sort of bag, or knapsack, and by the continual removal of the carbonic acid and the replacement of the oxygen, it is maintained in a normal condition for breathing.

While these ideas are readily seen to be entirely applicable, there are numerous details of construction and proportion which have been found to require study and experiment, and the importance of insuring the continuous and satisfactory working of the apparatus is appreciated when it is remembered that both the life of the wearer and the success of the rescue work in which he may be engaged may be imperilled by any interruption or failure of operation. For these reasons the investigations carried out in Germany are of much importance and value, apart from the general interest which they possess from a technical viewpoint.

It is desirable that any such apparatus shall be wholly automatic, requiring no attention or regulation on the part of the wearer, since he naturally requires the greatest freedom of thought and action for the work in which he is engaged, and great care must be taken that he shall be free from any irritation or inconvenience from the apparatus which he is carrying.

The absorption of the carbonic acid is effected by various materials. In the older devices a solution of soda-lime was employed, but there are objections to this, both on account of the imperfect absorption of the carbonic acid, and also because any liquid is inconvenient for transport, and because even a small amount carried in suspension in the air acts to irritate the mucous membrane of the organs of respiration.

The improved methods employ a dry absorbent, preferably caustic potash, but care must be taken in its employment, since the moisture in the exhaled breath acts to form a solution which, re-evaporated, may be inhaled and produce severe irritation. The extent of this difficulty will appear when it is stated that the watery accumulation of two hours amounts to about 120 cubic centimetres, forming a strongly caustic liquid. The remedy for this difficulty is found in the provision of some convenient substance for the absorption of the moisture, such as charcoal, or kieselguhr, or infusorial earth, such methods being found wholly effective.

The replenishing of the oxygen of the air is controlled by a reducing valve, which can be so adjusted as to permit a flow from the high-pressure reservoir at such a rate as to correspond to the consumption by the wearer of the apparatus. Some interesting experiments have been made in this connection, a résumé being given in Director Meyer's report, to determine the proper amount of oxygen to be supplied. These experiments, conducted by Dr. Leo Zuntz, of Berlin, upon bicycle riders, show that a rider, while standing, required 263 cubic centimetres of oxygen. The same individual, while operating his bicycle at the rate of about 21 kilometres per hour, required 2,351 cubic centimetres of oxygen, or nearly 9 times as much as before, the increased demand being the result of the muscular exertion. Experiments at lower speeds showed the reduction in the demand with the reduced effort; thus, a speed of 15 kilometres was accompanied with a consumption of 1,442 cubic centimetres per minute, while for a speed of about 9 kilometres the demand fell to 932 cubic centimetres. Comparing these with earlier investigations, as well as with some more recently made, it appears that the consumption varies for different individuals, and that the high rates correspond to brief periods of unusual exertion, not to be continuously maintained. An average consumption may be taken at 1 litre, or 1,000 cc., and the Walcher pneumatophor provides 2 litres per minute as an amount which may be supplied on demand.

Various details of arrangement of apparatus are shown in the report of Director Meyer, these being mainly directed toward the arrangement of the parts to insure strength and convenience. The air reservoir is usually made in the form of a flat bag, to be strapped to the shoulders, and it should combine the qualities of lightness with great toughness and strength, since any rent or tear would be fatal. The oxygen is contained in one or more metal flasks, with a volume of about 2 litres, the oxygen being compressed to 120 atmospheres, and thus furnishing a supply for about two hours. Usually three oxygen flasks are provided, each with its own valve, so that one may be used after another, this enabling the reduction of pressure to the regulated, besides providing against a loss of the entire charge should a leak in any one flask occur. The oxygen is supplied to the air automatically through a reducing valve, a variety of injector delivering a fine jet of the gas into the current of air which is to be regenerated. A special form of mouthpiece fits over the face of the wearer, including tubes for the nostrils, and the various designs shown indicate the care which has been taken to present the minimum of inconvenience to the wearer.

In addition to the provision for the regeneration of the air used by the wearer, the apparatus includes a connection permitting the use of a portion of the oxygen for the resuscitation of individuals who may be reached in the course of the rescue work, a feature of the utmost value.

The report is fully illustrated, and contains interesting information concerning experimental trials which have been made with various forms of apparatus, and the whole forms the latest and fullest contribution to this important department of mining work.

PROBLEMS OF ENGINEERING EDUCATION.

THE OUTLOOK FOR TECHNICALLY EDUCATED MEN IN FIELDS OF PRACTICAL ENGINEERING WORK AND APPLIED SCIENCE.

C. Frank Allen—Society for the Promotion of Engineering Education.

ONE of the elements in technical education in the United States commented on most freely by visitors from other countries has been the promptness with which the graduates from technical colleges are received into practical work. In England even yet the old-time practice of requiring a premium in money as a condition of admittance into an engineering works or office holds good, and some time in addition must elapse before the applicant can expect to receive a living wage, while in the United States the experience of many professors in the more important educational institutions is that the best members of his graduating classes are offered paying positions before they have received their degrees.

In the presidential address of Professor C. Frank Allen, before the meeting of the Society for the Promotion of Engineering Education at St. Louis, this matter is discussed at length, the various openings for technical graduates being examined in turn.

"Employment in engineering has generally but not always proved the goal for the graduate. In many cases it has rather been the channel, the period of preparation or probation for duties of a somewhat different character. In an increasing degree it has been found advantageous and desirable to secure superintendents, managers, presidents of railroads and other semi-engineering enterprises by promotions from among the school-trained engineers. The policy of that splendid railroad system, the Pennsylvania, has long since been established; the civil engineer engaged upon maintenance of ways finds himself directly in line of the office of Division Superintendent, to whom in turn the office of General Manager or even of President is in line and an evident possibility. A large number of mechanical engineering graduates are now entering upon railroad work; indeed, in many instances in the past they have been selected to occupy the highest operating positions; there seems no reason why the prizes in future should not be fairly or evenly divided between the mechanical engineers, while the rapidly increasing importance of electrical propulsion, and of electricity in signal work and otherwise will shortly demand a knowledge of electricity which will give to the electrical engineer an importance in general railroad work sufficient to introduce a new element of competition which the civil and mechanical graduates must face."

Professor Allen includes in the openings for technical graduates the field of contract work, and in this much discussed department of industry his views are of interest as being distinctly broader than is sometimes the case.

To some this has seemed, in civil engineering at least, as a lowering of dignity. A somewhat broader view appears to be that methods of executing wok are often more important as features of engineering than is the ultimate design. Furthermore, if the school-trained engineer-contractor does bring to his work greater skill in execution, greater pride in honesty of construction, and a better analytical understanding of the cost of various elements of the work, with diminution of the risk, and a consquent lowering of the cost (as I believe he does) then the contractor is not and ought not to be, as sometimes in the past, in any sense a constitutional foe of the engineer in charge, but rather a help, or better, an engineer legitimately in the practice of a special branch of engineering which ought properly to attract those whose abilities and tastes lead them towards it. In bridge work, machine shops, electrical manufacturing and installation, and many kinds of engineering it has long been true that the standing of the contractor has been inferior on the whole to no other class of engineers."

One of the most interesting features of the subject, as brought out by Professor Allen, appears in the extent to which men with engineering training are found in demand for other departments of work. Formerly the engineer was supposed to be a specialist, and the general collegiate education was assumed to be the real thing to equip a man for the more general duties of life. It is becoming evident, however, that a training in methematics and science is such as to bring out the best qualities in a man to as full an extent as can be done by a study of the classics and philosophy.

"The field chosen by the individual for his opportunity is not always pure engineering. While the demand for engineering and the demand from engineering enterprises, the demand for engineering graduates, the demand for engineering education is strongly on the increase, yet the day of trouble is before us, the day of financial crisis, when enterprises languish, when the demand falls sharply off, and the supply continues, although in diminished numbers. Then will come the time when the practicing engineer and the engineering graduate will find a necessity, not now existing largely, to make for himself his opportunity which will lie outside the established lines of engineering; when he must accept not what he would but what may be offered, and the engineering graduate will be forced into general business, into manufacturing. It seems reasonable that his greatest usefulness will first be found with dealers in engineering or mechanical supplies, or in manufacturing where engineering skill can never be amiss; already the demand in these directions has become a reality, rather than a possibility. Already some of the manufacturers' insurance companies employ a large force of men trained in engineering. Life, fire and marine insurance constitute, likewise, reasonable fields. Banking, and the sale of stocks and bonds, are occupations to which in many instances engineering graduates have already found themselves adapted by the training they have received and in which the line of study followed in the engineering college has been found frequently to be of practical advantage."

It has been maintained by some that the training imparted in an engineering course impairs the development of the executive ability, but there appears to be no good reason why this should be the case. There is no doubt that many men now holding executive positions of importance have come from the class of technically educated students, and evidence on the other side appears to be wholly lacking.

An important element in engineering education appears in the manner in which honest and sincere methods of thought are inculcated. A man may deceive others, or even himself, by sophistical arguments, so long as the matter goes no further, but when his deductions are obliged to be incorporated into iron, steel, stone, or concrete, or when his theories are compelled to be put into active motion and intrusted with the responsibility of lives and fortunes, he realizes that the defects will make themselves known, despite any argument or verbal juggling. An engineer must be an honest man, so long as he deals with the laws of Nature, laws which have an inconvenient habit of enforcing themselves, without possibility of deception or persuasion. Herein appears the moral side of an engineering education, which, as Professor Allen says, is a natural result of an intimate acquaintance with scientific methods and reasoning.

"The study of science is, it must be, the search for truth, and it must from usage cultivate a love for truth. That the scientific attitude of mind is of supreme importance as an element of character building seems to me in principle to admit of no doubt. As a matter of observation, I know of no class of men whom I believe to be less subject to business corruption than the civil engineers who have come more especially under my notice, and I do not doubt that the school-trained mechanical, electrical and mining engineers are men of equally high character.

"The influence of a training in methematics and science is also calculated, it seems to me, to develop another important element of character. The student learns in mathematics that correct procedure will secure correct results; in science correct observation and proper reasoning again will secure correct results. A clear appreciation of these truths naturally leads to the establishment of that quality of character which we call courage. An engineer unless he is trained so as to have acquired something of courage is comparatively valueless. A very able editor in the engineering field once stated that an important value of engineering education is that it enables one to look a fact in the face. It sometimes takes courage to do that. To me it seems most important that any business man should have learned courageously to look facts in the face; if the facts show not only present but also future losses as the result of continuance of a given policy or even of a given enterprise, the sooner the truth is known the better. Not all business men are proof against self-deception."

Professor Allen certainly appears to have made out a good case for the standing of the technically-trained man in the community, and we have only to look about us to see for ourselves the extent to which his views are confirmed by experience.

THE DEVELOPMENT OF THE FORGING PRESS.

APPLICATIONS OF HYDRAULIC PRESSURE FOR THE FORGING OF IRON AND STEEL IN PLACE OF THE STEAM HAMMER.

Baumeister Peter—Glasers Annalen.

THE persistence in the use of the hammer for the purpose of forging iron, is an excellent example of the manner in which mechanical practice has been diverted from the true logical line of development because of the influence of precedent. The hammer was undoubtedly the best tool for use by the human arm, therefore, when power came to be applied to the same work a bigger hammer was used, the details of the old-fashioned tilt hammer following the construction of the hand hammer as closely as the early railway carriages copied the lines of the stage coach. Even when Nasmyth broke the precedent by designing a steam hammer without a handle, he failed to realize that the true method of forging was by use of Bramah's hydraulic press, a machine which had already been perfected for other work and was ready to his hand. It was not until the magnitude of the work reached limits which made it apparent that the time element entered into the operation, and that a quick blow did not affect the interior of a mass to a sufficient extent, that engineers turned to the method of forging by pressure instead of impact.

In recent issues of *Glasers Annalen* the development of hydraulic forging machinery is discussed at length in an admirably illustrated article by Baumeister Peter, and from this we make some abstracts, reviewing the salient points.

The use of pressure in iron working appears in other departments than forging at an early date. The operations of rolling are also processes of working by pressure, but the first use of direct pressure appears in the employment of the "squeezer" for the expulsion of the slag from the puddled metal. Various forms of squeezers were used, the earlier types being of the alligator model, again following precedent and using what was really an enormous pair of pincers, operated by a cam movement, for compressing the ball of hot metal between its jaws. Later the rotary squeezer was designed, the metal being rolled through a gradually diminishing space between a fixed housing and an eccentrically placed roll. The hammer maintained its supremacy for forging, however, until it became evident that external pounding of large masses acted only to condense the exterior portion, leaving the interior nearly in its original open and porous condition.

The development of hydraulic forging and other forming operations by hydraulic pressure was greatly advanced by the introduction of the hydraulic accumulator. This avoided the necessity of using a pump capacity otherwise required for the maximum demand, besides equalizing the load and giving a smoother action to the ram of the press than by direct pumping.

Herr Peter illustrates the development of the forging press by showing the various forms successively, although the machines given are principally from German practice. The earlier presses of Haswell and of Whitworth are shown, followed by the improvements of Davy, Fielding and Platt, Krupp, Haniel and Lueg, and others, and the attention which has been given to detailed improvements is very clearly exhibited. Thus it was soon found that a marked economy in water was effected by using small auxiliary cylinders for raising the ram after a pressure stroke had been made, this arrangement also enabling a quicker return stroke to be made. Various arrangements of cylinders have been adopted by different builders, but in general the forging press consists of a massive upper and lower yoke, connected by strong columns, one yoke carrying the cylinder, with its ram and the other supporting the anvil, as it may be termed, the pressure being opposed by the rods which tie the two yokes together. Some presses have more than one ram, and the minor details are modified to suit the nature of the work.

Modern accumulators permit the use of working pressures ranging from 2,500 to 10,000 pounds per square inch, the total effort exerted by the ram reaching, in the case of the great press at the Krupp works, as high as 5,000 tons; while the press at the Bethlehem Steel Works exerts a total pressure of 14,000 tons.

Herr Peter reviews the auxiliary arrangement for use in the working of hydraulic forging presses, including the furnaces for heating the metal, the various handling devices, cranes, hoists, etc., giving an excellent idea of modern practice. He also gives a number of examples of the manner of working large shafts, armor plates, and other pieces of forge work, with illustrations.

In addition to the use of hydraulic power for forging, it is coming into use for shearing heavy masses, such as armor plates, and also for operating forming presses for shaping heavy boiler plate for boiler heads, and for special shapes. The bending press is also found valuable for curving the heavy plates required for the shells of marine boilers of the Scotch type, and for shaping armor plates for special positions, such as the protection of turrets, babettes, and conning towers of battleships.

The paper of Herr Peter is a satisfactory contribution to a department of modern shop practice concerning which but little has been published, and such articles are to be welcomed as useful additions to technical literature.

THE FIRE RESISTANCE OF MODERN HIGH BUILDINGS.

EFFICACY OF MODERN METHODS OF FIREPROOFING WHEN INTELLIGENTLY AND HONESTLY EXECUTED.

Perez M. Stewart—International Association of Fire Engineers.

AT the recent meeting of the International Association of Fire Engineers at Chattanooga a paper was presented by Mr. Perez M. Stewart, reviewing at length the lessons of the year in regard to the effectiveness, or otherwise, of modern systems of fireproofing, with especial reference to the protection of modern high buildings; a subject of such vital importance to the community, and so closely allied to the work of the engineer in many directions, as to demand notice and review.

During the past twelve months several exceedingly large fires have occurred, and these disasters have fully sustained the theory and practice of modern fireproofing methods.

"A more complete vindication of the contentions of fire protection engineers generally could not have been had than was given in the great fires at Baltimore, Rochester and Toronto. Each type of material, each method of building practice failed or sucsucceeded in accordance with the knowledge and belief of all who had made, previously, a study of the subject. There were no surprises, only vindication—vindication of the prophecies of disaster made last year, made now and to be made in all the years to come, so long as improper materials and bad engineering practice enter into the composition of our buildings. Too much emphasis cannot be laid upon the vital need of high standards of specification and of living up to them in matters pertaining to fire protection, for, as a famous underwriter has said: 'Fire protection is peculiar in that to be efficient it must be complete. No compromise is possible, since ninety-five per cent. of efficient construction may be vitiated by five per cent. of omission, oversight or misjudgment.

"The force of this is obvious when it is considered how intimate are the relations among the fire resisting properties of the different members of a building; how the failure of one member may throw an added burden on another and at the same time deprive that other member of the power to sustain its original burden."

It is in this respect especially that questions relating to fireproofing demand the attention of the construction engineer to a greater degree than is sometimes found. The loads, wind stresses, shocks, and other elements are all carefully computed in determining the proportions of the various members, without considering that in many instances more mass is required to resist fire than to meet all the other stresses taken together. The first requisite in the design of a fireproof building, then, is an appreciation by the engineer that stiffness and solidity of construction must be provided, and that a flimsy built structure, with just a little more strength than is required to resist the mere statical loads, is not a proper framework for any system of fireproofing.

Good designing, however, is of little avail unless it is followed by honest workmanship, and unfortunately this is not always the case.

"The standard of workmanship in buildings is very low—often criminally so. The factor of safety provided in the design against other contingencies is often drawn upon to the limit of failure as tribute to dishonesty and carelessness. Owners need to learn the value and the necessity of adequate inspection, and it does seem that some architects should enlarge their ideas of what is meant by the word 'supervision.'

"Finally, it may be said that much of the damage at Baltimore was due to poor workmanship as well as to flimsy design. Many terra-cotta partitions and column coverings were so loosely laid up that they were entitled to fall down without any other excuse at all. There were cubic yards of bricks in the walls of the Continental Trust Building which were simply thrown in loose without any pretense of laying. It should be remembered that good workmanship may save a defective design, but no excellence of design can adequately provide against dishonest work.

"Again and again cases are met with where effective fireproofing was specified for buildings by the architect or engineer, for which, in the construction, an inferior method was substituted by the contractor, supported by the owner, simply because it was cheaper, resulting, seemingly, in a saving to the owner, and undoubtedly in an increased profit to the contractor."

One of the difficulties encountered in advocating proper design and honest execution of the work is found in the attitude of the owner. This difficulty has been well stated by Mr. Edward Atkinson in words which will well bear repeating.

"The mental attitude of the average owner and occupant toward the underwriter becomes of prime importance; as a rule, it is antagonistic. The owner is apt to think that his only duty is to secure an efficient fire department, an excessive public water supply, and to take out a policy of insurance on his property. This policy he seldom reads and often could not comprehend it if he did. He trusts to an insurance broker or agent to make the contracts on the best terms, being eager for a low rate, whether adequate or not to keep the insurance companies solvent. He may put in private apparatus and may hang up cheap hose only to satisfy the inspectors of the insurance company, whom he looks upon as inquisitive persons to be tolerated, but gotten rid of with the least trouble. He rarely, if ever, seeks to know what avoidable causes of hazard the inspector may have found, and he grumbles when the rate of premium is put up. He often tries to prove a larger loss than has occurred and to get as much as he can out of the adjusters when fire has damaged his property. He seldom comprehends and utterly neglects his own responsibility for the construction and protection of his own property.

"The complete removal of such hazards will only be attained when occupants as well as owners can be brought into a psychological condition or mental attitude in which they will welcome the underwriters and their inspectors as their next friends, instead of resenting their inspections and regarding them as a necessary evil to be tolerated, but to be ignored as much as possible."

Coming to the actual methods of protection, and assuming as absolutely essential a strong and massive steel skeleton, upon which to place the protection, the results of recent experience show that nothing is better than a high grade of Portland cement concrete. This has shown itself superior to hollow tile, to plaster of Paris blocks, or to plaster on metal lath. The best material, however, is ineffective if the protection is too thin, or is not properly secured.

Mr. Stewart gives a number of examples of recent fire-proof construction, showing that proper protection is altogether possible by the adoption of proper engineering methods in design, followed by sincere and honest construction, with owner and builder in accord as to the fundamental importance of adhering strictly to the accepted principles of scientific fireproofiing.

To put the matter briefly, the several fire hazards and means for their reduction may be summed up in general as follows:

Iron and steel structural building members lose their strength rapidly under the influence of even moderate heat, therefore should be thoroughly insulated. Portland cement concrete and hollow tile, not less than two inches in thickness at any point, are most efficient against the attack of both fire and water.

Vertical openings throughout buildings, as for stairs and elevators, rapidly communicate fire between stories. With buildings of considerable height or combustible contents this is likely to result in fire conditions beyond fire department control. All such floor openings should be enclosed in brick walled shafts, crowned by a thin glass skylight and extending through roof and with fire doors at openings to stories. All vertical light openings in such shafts should be glazed with wire glass.

Large, unbroken floor areas assist the spread of fire and serve to augment its severity. Buildings of considerable area and having large quantities of combustible contents should be sub-divided by substantial brick fire walls sufficient to form a positive barrier to the spread of fire.

Stair treads should preferably be of iron or its equivalent. If slate or marble treads are used they should be supported by a metal plate beneath.

A large portion of fuel for combustion, in buildings having brick walls, is supplied by the trim, floors, etc., as well as by such furnishings as are necessary for occupancy. Much of this can be avoided by the use of substitutes for wood, or of metal-clad covered wood and metal covered furniture.

Nearly one-third of the total fire loss is caused by the contribution of flame from one building to another through window openings. All windows subject to exposure should be thoroughly protected against the attack of heat. Wire glass in non-combustible frames has proven most efficient for the purpose, as it is always in position and is not subject to deterioration.

Every aid to the fireman, in the shape of fixed equipment in the building, adds so much to his capacity. Fire alarms and thermostats, standpipes, stationary nozzle and sprinklers all mean more prompt and efficient application of water, and should be most generously and generally encouraged.

Last and most important, and this applies to the whole range of fire loss reduction, only such systems and devices as have demonstrated their efficiency should be specified, and only such workmanship as lives up to the most rigid specifications should be permitted.

It is not to be expected that reform can be instituted very rapidly. Prejudice—especially that form against things not wholly understood—must be overcome, municipalities must be goaded into action, and every aid invoked if we would hasten the time when all but the most extraordinary fires can be confined to the floor, or at least to the single building in which they originate.

ELECTRIC TRACTION FOR RAILWAYS.

FEATURES IN THE HISTORY AND DEVELOPMENT OF ELECTRIC POWER AS APPLIED TO RAILWAY TRACTION.

International Electrical Congress.

WHILE the applications of electric power have appeared in many useful ways there is probably no direction which has been made more apparent to the general observer than the substitution of electric for animal power on street and local railways. The development of electric traction for interurban service is an extension of local tramways, and numerous predictions have been made as to the ultimate replacement of steam by electricity for main-line service.

Such an important department of applied electricity naturally received attention at the International Electrical Congress at St. Louis, and among the important papers presented we note a valuable contribution to the history of the subject, by Frank J. Sprague, an account of his pioneer work in single-phase electric traction, by Bion J. Arnold, together with papers by Charles Proteus Steinmetz, R. A. Parke, Professor Dr. Niethammer and Lewis B. Stillwell.

Mr. Sprague reviews the early history of electric traction, noting the pioneer experiments of Davenport, in 1834, followed by the work of Jacobi, Farmer, Page, and others, before the introduction of the dynamo, after which the experiments of Siemens & Halske, Felix and Chretien, Deprez, and others, directed the attention of engineers to the possibilities of the application of electric power to traction purposes.

After the dynamo was more fully developed, and the possibilities of the electric motor began to be appreciated, numerous engineers were attracted to the subject of electric traction, the most active experimenters being Field, Reckenzaum, Van Depoele, Daft, and Sprague himself.

"Reviewing the conditions at the beginning of 1887, statistics compiled by Mr. T. Commerford Martin show that, including every kind of equipment, even those a fraction of a mile long and operated in mines, there were but nine installations in Europe, aggregating about 20 miles of track, with a total equipment of 52 motors and motor cars, none operated with the present overhead line or conduit, and seven cars operated by storage batteries, while in the United States there were only 10 installations, with an aggregate of less than 40 miles of track and 50 motors and motor cars, operated mostly from overhead lines with traveling trolleys flexibly connected to the cars. These were part Daft, but principally Van Depoele roads. Almost every inventor who had taken part in active work was still alive. The roads, however, were limited in character, varied in equipment and presented nothing sufficient to overcome the prejudices of those interested in transportation, and command the confidence of capital. The whole electric railway art may fairly be termed, and was in fact for sometime afterward, in an experimental condition, and some radical step was necessary to overcome the inertia which existed, and inaugurate that development which has been so remarkable.

"This came in the spring of 1887, when the Sprague Electric Railway and Motor Company took contracts for roads at St. Joseph, Mo., and Richmond, Va., the latter covering a road not then built, and including a complete generating station, erection of overhead lines, and the equipment of 40 cars each with two 7½-hp. motors, on plans largely new and untried. The price, terms, and guarantees were such as to impose upon the company extreme hazards, both electrical and financial. The history of the Richmond road has been too often written to dwell upon it at any length here. Suffice it to say that after experimental runs in the latter part of 1887, it was put into commercial operation in the beginning of February, 1888, and for a year there followed an experimental period of development which taxed the technical and financial resources of the company to the limit. But it won out, and Richmond, by common consent of history, now stands as that pioneer road which more than any other was effective in the creation of the electric railway as it stands to-day."

After the success at Richmond had demonstrated the practicability of electric traction for street railway service, various improvements were made, but the next awakening demonstration, largely by reason of the public nature of the situation, was the Intramural railway at the World's Fair at Chicago in 1893. This was soon followed by the application of electric traction to a portion of the elevated system in Chicago, and by the general replacement of cable traction in cities by electric traction, the overhead trolley system being very generally used.

The paper of Mr. Bion J. Arnold gives some interesting information concerning the replacement of the 500-volt continuous-current system for electric traction, by alternating currents at higher voltages, including the employment of transformers and converters at sub-stations. The account which he gives of the plans for the Inland Lakes Road, a line designed in 1896, but never executed in its entirety, is most valuable, as showing the difficulties opposed to a system now in general and most successful service. The important portion of Mr. Arnold's paper, however, lies in the detailed account which he gives of his system for the direct use of the single-phase alternating-current motor for traction. This system is in reality a combination of electric and pneumatic traction, the power being derived from a constant-speed single-phase alternating-current motor with reversible air compressors and engines, the pneumatic portion of the machinery absorbing and giving out energy as required, and permitting the electric motor to be run at a constant speed. This arrangement gives the alternating system the flexibility otherwise lacking, and permits the direct use of alternating currents for traction without involving the use of two or more contacts as demanded by polyphase systems.

Dr. Niethammer discusses the development of electric traction in Europe, comparing alternating and direct-current systems, illustrating many important installations, including the polyphase systems of Switzerland and of northern Italy. His summary of the situation in Europe is interesting, especially in the light of what is being done in the United States.

"Years ago direct current was declared entirely unsuitable for long lines and heavy traffic; to-day many give up three-phase and direct current to use only single-phase, of which we know very little as yet, from a practical standpoint. I believe that all three systems may counterbalance each other; yet each of them lacks some desirable features. Direct current is restricted to low train voltages and needs expensive sub-stations; three-phase railways make two trolley wires necessary, are very sensitive to voltage variations and badly overload the central stations; the last two disadvantages are more or less applicable also to single-phase lines, which possess the additional troubles on the commutator and the low efficiency. None of the systems offers the possibility of running through parts of the line independently of an outside current source. Up to the present neither of the other systems is known to be as reliable and safe as the direct current. The first costs of the car equipments are throughout higher for three and single-phase than for direct current; for equal voltage the line equipment is cheapest for direct current; but the possibility of using high trolley voltages for alternate currents shifts the result essentially in favor of single and three-phase currents, mainly the former. The sub-stations are more expensive for direct current, while the central station costs least for direct current. As to the operating expenses, the cost of attendance for the sub-stations is unfavorable to direct current. The result of serious comparison between the systems shows usually a difference in first cost of not over 10 to 25 per cent. and the difference in operating expenses is even less and in many cases the results are in favor of direct current, between three-phase and single-phase there is no essential difference as to price, single-phase having the advantage of simplicity and the possibility of higher trolley voltage, but possesses the disadvantage of needing a commutator.

"For long lines and heavy trains with low accelerations, three-phase equipments will always have good chances, especially if through trains are arranged and all shunting is done by special engines. On urban and suburban lines, direct current is entirely sufficient and satisfactory, though a reliable single-phase motor will be a hard competitor, as single-phase equipments may be arranged to suit both long and short lines."

Some idea of the progress which has been made in the application of electricity to the purposes of traction will be gathered from a summary of statistics given by Mr. Sprague, together with an indication of what this new industry has accomplished for the welfare of mankind.

"To illustrate in a general way the growth of the electric railway it should be noted that three years after the inauguration of the Richmond road there were in operation or under contract in the United States, England, Germany, Italy and Japan, not less than 325 roads, representing an equipment of about 4,00 cars and 7,000 motors, with 2,600 miles of track, on which there was made a daily mileage of not less than 400,000 miles, and three-quarters of a billion of passengers were carried annually.

"By the end of 1903, in the United States alone, there was a total of over 29,000 miles equipped, 60,000 motors and 12,000 trail and service cars in service, and the passengers carried ran into billions.

THE EFFICIENCY OF THE GAS TURBINE.

A THEORETICAL STUDY OF THE CONDITIONS OF ACTION BASED UPON DATA FROM PRACTICAL TRIALS.

Alfred Barbezat—Schweizerische Bauzeitung.

WITH the rapid and successful development of the steam turbine it has occurred to a number of engineers that a similar successor to the gas engine in the form of a gas turbine might readily be made. Some experimental work has been done, both in the United States and in Europe, but very little information has been made public, this indicating that the practical results have not been attended with that degree of success which would warrant any commercial undertakings. It now appears that Messrs. Armengaud and Lemale have been running an experimental turbine, driven by the direct products of the combustion of petroleum at constant pressure, and that this machine has been in operation for more than a year in the works of the *Société des Turbomoteurs* at Saint Denis, near Paris.

In a recent issue of the *Schweizerische Bauzeitung* this machine is described in a contribution by M. Alfred Barbezat, who proceeds to develop a theory of its action by means of which the efficiency for any given temperature range may be computed. The mathematical nature of the article is such that it cannot be reviewed at length, but must be studied in the original, although the results are expressed in graphical diagrams which are useful as means of applying the results. A section of the generator and machine is also given, showing the extreme simplicity of the apparatus, and its applicability as a motor.

It is not maintained that the gas turbine will give a higher thermal efficiency than the reciprocating gas engine, but it is believed that to all the great advantages of the gas engine will be added those of the steam turbine, including simplicity, continuity of action, lightness in proportion to the power developed, economy of space, together with freedom from the incumbrance of boiler and furnace. An important advantage especially is seen in the substitution for the intermittent action of the Beau de Rochas cycle, of a continuous tangential impulse upon the rim of the wheel, the gain in this respect being greater for the gas turbine over the gas engine than in the case of the steam turbine over the reciprocating steam engine.

In the Armengaud and Lemale apparatus the combustion takes place in a pear-shaped vessel, the air and petroleum being delivered under pressure at the large end, through a special form of burner.

The burner is of annular form, the liquid fuel being delivered in the middle and the air around it, while the gases and products of combustion are discharged from the other end, through a suitable diverging nozzle, directly against the double buckets of the wheel; this latter being similar in construction to a Pelton water wheel.

The combustion chamber is protected against overheating by a water jacket arranged in the form of a spiral passage formed in the thickness of its walls, the water thus becoming continually hotter and hotter as it proceeds, until it is finally discharged in the form of vapor into the interior of the chamber through a series of small holes arranged around the entrance of the discharging nozzle. The intense heat at this point adds to the expansive force of this vapor of water, and thus all the heat which has been absorbed by the water jacket is delivered with the hot gases against the turbine wheel as energy. The air, liquid fuel, and circulating water are delivered by suitable pumps deriving their power from the turbine itself, so that the available power is the difference between that generated by the turbine and that absorbed by these pumps. It may be of interest to compare this generator with the constant-pressure generator of Mr. Warren, illustrated and described in our issue of February of the current vear, both devices using the vapor of the cooling water, mingled with the gases of combustion, for delivery to the motor. In the Armengaud and Lemale generator a temperature of 1,800° C. is maintained in the combustion chamber, the constant expansion of the gases and vapor of water causing a stream of high velocity to be discharged through the nozzle upon the buckets of the turbine wheel.

M. Barbezat takes the data derived from these experiments, and discusses them in accordance with the thermodynamic theory of gases, drawing curves corresponding to the energy evolved as well as that consumed by the air compressor, from which it appears that with a temperature of combustion of about 1,800° C. and a temperature of discharge of 920° C. in the gases delivered against the wheel, the efficiency of the apparatus will be about 18 per cent.

In this case the initial pressure is about 15 kilogrammes per square centimetre, or about 212 pounds per square inch, and this performance is not better than is already obtained with the reciprocating gas engine, and is decidedly lower than is given by the best petroleum motors, such as the Diesel. At the same time the advantages of the continuous rotary motion, together with the simplicity of the machine renders it important that thermal efficiency alone should not be made the criterion by which the machine is judged. It is also possible that higher pressures may be used to advantage, and that the temperature range can be increased, so that still better results may be attained. The fact that a practical gas turbine has been made and operated continuously is in itself a matter of technical interest worthy of note, and if the machine receives but a portion of the attention which has been given to the steam turbine or the reciprocating gas engine, it is probable that further improvements will be made.

STEAM POWER-PLANT ENGINEERING.

DATA AND RESULTS OF ECONOMY TESTS OF A REARRANGED STEAM POWER PLANT IN A MANUFACTURING ESTABLISHMENT.

E. G. Hiller—Institution of Mechanical Engineers.

AT the present time, when the whole constitution of power-plant engineering is undergoing revision it is especially important to have reliable data available as to the performance of the various claimants to public favor. The steam engine of the older reciprocating type is finding its pre-eminence assailed by the turbine for large installations and by the internal-combustion engine for the smaller powers, while the distribution of electric power from central stations comes in as a factor to be considered by power consumers of all kinds. The mill owner naturally hesitates to make radical changes unless he is convinced that nothing better than he now has can be offered, and in many instances he believes that the best thing to be done at the present period of transformation is overhaul the old plant along modern conservative lines and await developments. It is in such a manner that the power plant of the Bessbrook Spinning Company has been rearranged, and an interesting account of the manner in which the work has been done, and the results accomplished, forms the subject of a paper recently presented before the Institution of Mechanical Engineers by Mr. Edward G. Hiller.

Mr. Hiller rightly maintains that the aim in the installation and operation of such a plant should not simply be to obtain an engine which would use the smallest number of pounds of steam per indicated horse power per hour, but one which would, taking into account the capital, maintenance, fuel, water, and other incidental expenses, produce the power required on the flywheel at the lowest total cost for steam plant.

"The alterations at the Bessbrook Mills are an interesting example of the advantage of converting a group of old mills, driven by separate and independent steam engines, to a method of driving from a central station with more modern and economical plant.

"In the case of the Bessbrook Mills, the buildings formed three sides of a quadrangle, with one wing forming an extensive weaving shed, driven previously by a separate horizontal cross-compound tandem engine with horizontal air-pump. The other wing was driven by bevel gearing from the main block. The main block itself consisted of two mills placed end to end, with each portion driven by a separate engine. One of these engines was an old pair of beam engines, and the other engines a pair of double tandem compound horizontal engines. The three engines drove by gearing, there being altogether three upright shafts and three sets of horizontal second-motion shafts.

"The most suitable site for the new engine was on the side of the mill furthest from the present boiler house, and, consequently, an exceptionally long steam pipe range was necessary. Due account had to be taken of the high price of coal at Bessbrook (which may be taken approximately at 16s. per ton), the necessity for avoiding breakdowns, the isolated position of the mills in the country, and their distance from any large engineering centre, where, in the event of breakdown, skilled workmen could be readily obtained.

Without going into the details of the new engines and steam plant which are given very fully in the paper, it may suffice to state that it included a horizontal compound automatic condensing engine, with a cylinder ratio of about 4 to 1, Lancashire boilers, and a Musgrave and Dixon superheater, giving a superheat of about 60° F. The engine is fitted with a reheater between the high and low pressure cylinders, and the tests show the performance both with and without this being in action. An interesting feature of the engine appears in the regulating apparatus.

"The governing of the engine is effected by an ordinary high-speed centrifugal loaded governor, assisted by a supplementary governor. The load on the main governor partly consists of a weight secured to the end of a screwed lever. The sensitive supplementary governor at the slightest change from middle position can, by means of gearing, slowly screw this lever and its balance-ball outwards or inwards if the engine varies from the desired mean speed, and this action takes place quite independently of any quicker movement of the main governors. In this way, while the prompt action of the main governor is not affected, nor the length of the governor-rods altered, as in some arrangements, it is possible to secure an almost dead mean speed irrespective of permanent load changes, vacuum variations, or boiler-pressure fluctuations.

The performance of the engine is excellent, the steam consumption being 11.25 pounds per indicated horse-power hour, and the fuel required being 1.46 pounds of coal per horse-power, as fired.

An interesting feature of the tests was the experience with grease separators, and tests of a number of such appliances given in the paper show that with condensing engines exhausting into a high vacuum the velocity of the steam is such that the entrained oil is nearly all carried along with the exhaust steam into the condenser and thence to the boiler. This was true both for separators consisting of a plain chamber and those fitted with baffle plates or diaphragms of wire gauze, and Mr. Hiller is of opinion that the preferable method of removing the grease from the exhaust, under these conditions, is by the alumina-ferric, or other allied processes.

The total cost of the plant, including the building, was about £18,000, while the operative economies effected show a saving of £3,000 per year, of which about one-half is due to the saving in fuel, and the balance in reduction in labour and other charges. This is about what has been shown in other cases, and in general it is well to bear in mind that the fuel cost in a steam power plant is generally about one-half the total operative costs, so that any ordinary saving in fuel affects the cost in about that proportion.

THE MONT BLANC ELECTRIC RAILWAY.

PLANS FOR THE CONSTRUCTION OF THE FIRST SECTION OF THE LINE FROM LE FAYET TO THE SUMMIT.

Col. G. Espitallier—Génie Civil.

IT is not so many years ago that the ascent of Mont Blanc was considered a feat to be accomplished only be expert Alpinists with the assistance of professional guides, and even now the ascent can be made only under official regulations, intended to enhance the safety of the traveller and the revenue of the natives. All this is now to be changed, and following the example of the Jungfrau, Mont Blanc is to acquire an electric railway by means of which the tourist may ride in ease and comfort to the summit, at a fraction of the cost of the former ascent. From an account of the plans which have been adopted for the construction of this line, in a paper contributed by Lieut. Col. Espitallier to a recent issue of *Le Génie Civil,* we make some abstract and review.

A concession made by the general council of the department of Haute-Savoie to the railway company, having been approved by the French government on August 3, 1904, plans are now being made for the immediate construction of the first section of the railway, extending from Fayet and Saint Gervais to the Aiguille du Goûter, a point situated at an altitude of 3,840 metres above sea level. The height of the summit of Mont Blanc being 4,810 metres (15,781 ft.) above sea level, it will be seen that this first portion will bring the traveller within 1,000 metres of the summit, leaving the balance of the height to be achieved by a subsequent section. Although the altitude to be scaled by the proposed railway will exceed by far that of any of the Swiss mountain lines, it is but 135 feet higher than that of the tunnel through the Andes, traversed by the trains of the Lima and Oroya Railway in Peru, so that the mere question of altitude offers no problems which have not already been successfully solved.

The first plan for the mechanical ascent of Mont Blanc was made by an able engineer, M. Issartier, in 1895, this unique proposition including a horizontal tunnel into the mountain, and a vertical shaft of about 2,000 metres height. The cost of this plan led to a modification, the entrance of the tunnel being placed at Houches, and the height of the vertical shaft being reduced to 1,000 metres. It was believed, however, that the prospect of making the greater part of the trip underground would render it unattractive to travellers and the scheme was abandoned. A subsequent plan, proposed by M. Souleyre, provided for a continuous ascending grade, but the steepness of the route selected was considered objectionable. The later propositions appear to have settled down into two variants, one starting the railway from the village of Houches, midway between Fayet and Chamonix, and combining the use of a tunnel and steep grades, while the other, by way of Le Fayet and Saint Gervais, employs more moderate grades, and enters the tunnel only towards the summit.

It is this latter plan which has been definitely adopted for the road about to be built, and there is every reason to believe that the scheme will be successfully executed in accordance with the route which has been determined. This line will be 18.5 kilometres long from Le Fayet to the Aiguille du Goûter, while the completed route to the summit of Mont Blanc will prolong this to 22.5 kilometres, or about 14 miles. By making the ascent over a course of this length the grades are kept within satisfactory limits, ranging from 9 per cent. to 23 per cent., and by far the greater portion of the route is open to the sky, the tunnels being near the end of the first section, as the Aiguille du Goûter is approached, the principal tunnel being about 2¾ kilometres in length, preceded by three shorter tunnels.

The route will sweep around the southern side of the mountain, encountering no very serious obstacles, and giving a succession of impressive views of the scenery of the region, and it will doubtless be found that the numerous points along the line will be developed into resorts for pleasure and health seekers. In the tunnels themselves the example of the Jungfrau railway will be imitated, openings through the side of the galleries being provided, with protected balconies at the station, permitting the travellers to descend and obtain, in perfect safety, views which can now be enjoyed only at great risk and cost.

In regard to the operative portion of the line, the experience which has already been had with the opened section of the Jungfrau railway has been considered, and the general details will doubtless include the most successful elements of that line. The track will be of one metre gauge, the loading gauge being also the same as on the Jungfrau line; 2.90 metres in height, and 2.50 metres wide. The rails chosen weigh 20 kilogrammes per metre, with steel sleepers, the rack, of the Strub type, being placed between the rails. It is intended to use the three-phase system of electric driving, with locomotives provided with two independent motors, as on the Jungfrau line, the current at first to be provided by some of the existing hydro-electric stations available, although an independent generating station may be constructed later.

From an engineering point of view, as has already been stated, there appears to be no reason why the Mont Blanc railway may not be successfully constructed and operated. Statistics of the mountain railways of Switzerland are given which show returns of more than 5 per cent. on the capital invested, while the development of the tourist business of the district naturally appeals to the same capitalists. There has been some opposition on the part of those whose æsthetic sense is offended at the idea of the profanation of the natural beauty of the locality by so prosaic thing as a railway, but experience has shown in other cases that the insignificant appearance of the track and vehicles, in the midst of such enormous masses of rock, ice, and snow, is a sufficient answer to such objections. The introduction of electric traction removes any annoyance from smoke or puffing of engines, and there can be no more real objection than might be advanced against any other method of making the ascent.

ENGINEERING IN THE FOUNDRY.

THE APPLICATION OF SCIENTIFIC PRINCIPLES OF OPERATION TO THE WORK OF THE FOUNDRYMAN.

Robert Buchanan—British Foundrymen's Association.

THE American Foundrymen's Association has won for itself honorable recognition as an important element in the work of engineer and manufacturer, and we are glad to note that there has been organized in Great Britain a British Foundrymen's Association, to unite the workers in iron into an organization which we trust will be an important element in the development of British industry.

The presidential address of Mr. Robert Buchanan, already well known to our readers by his valuable contributions to our pages, is an excellent indication of what may be expected from the new organization, and we make some abstracts of his address as indicative of the aims and ideals of the society.

The foundry has always been considered as a dirty and somewhat undesirable part of a machine works, and Mr. Buchanan does well to begin by declining to apologize for being a foundryman. As a matter of fact those who regard the foundry as an inferior portion of the works simply reveal their own ignorance of the high demands which foundry operations make upon the skill of the man to whose care this department of engineering is entrusted. Properly considered, the foundryman must be at the same time a mechanic, a metallurgist, and an engineer, and upon the skill with which he exercises his functions depends much of the success of the establishment to which he belongs.

Mr. Buchanan refers, in the opening portion of his address, to the subject of technical education, as related to the work of the foundryman, emphasizing the importance of proper elementary training, in order that coming generations may be able to avail themselves of the opportunities which are being prepared for them in the acquirement of technical education.

Passing from possible opportunities in the future, Mr. Buchanan plunges into the main subject of his address, the study, by the men in the foundry, of the phenomena daily occurring before their very eyes. The work of the foundryman consists in the melting of certain metals, or combination of metals, and the pouring of them into moulds which he has prepared. He deals with the phenomena which are seen in the heating, melting, and cooling of metals, and he has unparalleled opportunities of observing these phenomena. The theories which have been proposed concerning these things are numerous, but very few of the men who have propounded theories have had a fraction of the opportunities of observing these phenomena as have the men whose daily work lies in the foundry. Mr. Buchanan urges the foundrymen to avail themselves of their opportunities, and to study the things with which they have to deal daily, and learn to apply, confirm, or reject theory in the light of their own practical experience.

In order to discuss the behaviour of metals in passing from the liquid to the solid state, Mr. Buchanan compares them to the action of a solution of salt in water. Solutions, of various degrees of concentration, when cooled until solidification takes place, show that there are various elements, with different points of solidification. Similar actions occur with metals, and in the case of cast iron we may consider the material as a solution of carbon in pure iron, much as the salt was dissolved in the water. Upon this analogy the theory of eutectics, and the successive solidification of the various alloys of iron and carbon, is discussed, showing that all the elements contained in the material must be considered, and then no one of them can be assumed to be in a condition of separateness from the other elements.

Having thus shown the necessity for the consideration of all the elements contained in the metal with which the foundryman has to deal, Mr. Buchanan takes up the several elements separately, and examines the properties of silicon, manganese, phosphorus, and sulphur, showing the influence which they have upon the product, and the manner in which they should be treated.

Space will not permit us to discuss in detail the influences of the various elements met in the various grades of cast iron, as discussed by Mr. Buchanan, but the mere fact that a knowledge of such subjects is considered as important or necessary for the foundryman, shows the advance which has been made in this department of engineering work. Formerly a foundryman was considered but little removed from the status of a laborer, but now it is evident that he may aspire to a branch of metallurgical knowledge of recent development, but intensely practical and commercial importance.

A cupola man is now expected to be able to mix metal for definite classes of castings and temperatures, and he is supposed to have positive knowledge of his work, and not to be dependent upon guess work or empirical rules or methods. This means a distinct advance in the status of the foundryman's work, and with it must come a corresponding advance in the returns which it can give to the men who have the necessary information and ability.

The transformation which has taken place in the work of the machine shop and the iron works may be expected to enter also into the foundry, and the result must be a corresponding transformation in the status of the men who are to work on the moulding floor and before the cupola. Muscular labor will be more and more superseded by machinery, and the foundryman who is to survive must learn to use his head the more as he uses his hands the less, and his own position will be improved proportionally. A process of sifting out must go forward and those who survive will be those who have fitted themselves for the higher departments of the work, while the mere routine workers, who have neglected to keep themselves abreast with the progress of the times, will find themselves left behind in the movement. The formation of the British Foundrymen's Association is a hopeful sign of the times, and the character of the address of their President is an excellent indication of the aims and aspirations of the society. We wish them every success, and believe fully in the mission which is before them, the development of the work of the foundryman as one of the essential departments of modern engineering.

METHODS OF TESTING GAS ENGINES.

QUANTITATIVE DETERMINATION OF THE HEAT REJECTED IN THE EXHAUST GASES AS A MEASURE OF EFFICIENCY.

B. Hopkinson—British Association for the Advancement of Science.

IN determining the thermal efficiency of a heat engine it is necessary to find out what proportion of the heat supplied is returned in actual work. This means the accurate measurement of the heat supplied and the work produced, and it is upon the accuracy with which these two measurements are made that the value of the test depends. In the case of the steam engine the power is measured by the indicator, by some form of absorption brake, or by transformation and measurement as electric current, while the heat supplied is determined from measurements of the water evaporated by the boiler at determinate pressures and temperatures, or by measurement of the steam supplied. In some cases the quantity of steam consumed is measured by collecting the water produced by the condensation of the exhaust steam, and sometimes all three measurements are made.

The internal-combustion offers certain difficulties in testing, but these are being overcome as closer attention is being directed to the comparative efficiencies of different types and models. In those engines which are regulated by the hit-or-miss system of governing, great care must be taken to use indicator diagrams which represent the actual number of working impulses for a given time, but this source of uncertainty has been met by the use of continuous indicators, which give a series of diagrams extending over any desired length of time. The net power is readily measured by absorption dynamometers, or by conversion into electrical energy, while the heat supplied is generally determined from the quantity of gas supplied, and its calorific value. The heat carried off by the jacket water is capable of very accurate determination by the taking of its rise in temperature and its volume, and the usual method of stating the thermal balance of a gas engine is to give the heat returned as work, the heat carried off by the jacket water, and the heat rejected in the exhaust gases. In nearly every case, however, this last quantity is not measured, but is determined by difference, as a chemist would say, the assumption being made that all the heat which does not appear either in work or in the jacket water must necessarily pass out with the exhaust. This plan is open to several objections, the principal one being that it prevents any check upon the work, while if all the elements of the heat balance were measured independently the account might be scrutinized with the same precision as a bookkeeper balances his cash.

The real reason why the heat in the exhaust gases has been deduced instead of being measured lies in the fact that no convenient and accurate method of making the measurement had until recently been devised. At the recent meeting of the British Association for the Advancement of Science a paper was presented by Professor B. Hopkinson, describing a form of calorimeter through which the exhaust gases may be passed and the heat abstracted and measured, thus enabling a complete heat account to be obtained, lacking only the small losses due to conduction and radiation. Professor Hopkinson gives an account of the construction and application of this apparatus in connection with a test of small Crossley gas engine in the Engineering Laboratory, Cambridge, using Cambridge coal gas as fuel.

"The calorimeter for the exhaust gases consists of a section of flanged cast-iron pipe fitted with baffle-plates, by which the gases are caused to pass several times backwards and forwards through its length, and finally to bubble through the water collected at the bottom. The water, after passing through the jacket surrounding the calorimeter, meets the exhaust gases in a fine jet, and is partly caught by them and carried round with them, and partly trickles down the baffle-plates. It was found that in this way the gases could be cooled, with the engine fully loaded, down to 120 degrees F. or less, the cooling water rising in temperature from about 60 degrees to 90 degrees. This instrument was designed of ample proportions, so that it should be certain to work satisfactorily; there can be no doubt that it is big enough to serve for a much larger engine. In a test on an engine of double the power the calorimeter was very much smaller and the results quite satisfactory.

"There is no need to particularise the methods of indicating the engine, or of measuring the amount of temperature rise oi the jacket water, about which there was nothing peculiar. Some pains, however, were taken to secure accurate measurement of the heat put into the engine. The gas was measured with a wet and dry meter in series, and both meters were calibrated with a standard holder at the rate of flow of gas actually used. The calorific value of the gas was determined with a Junker calorimeter at the time of the test of the engine."

The results of the tests are tabulated in the paper, but as the engine was of an old model and no high degree of efficiency was expected, these are of moderate interest, except in connection with the matter of the distribution of the losses. In general the results of the earlier methods are fairly well confirmed, but there is a portion of the heat unaccounted for, which shows the desirability of the use of just such a method of investigation. Undoubtedly a portion of this loss is due to conduction and to radiation, and some is probably involved in the impossibility of absorbing all the heat in the exhaust gases. Professor Hopkinson shows that the difference unaccounted for in his first trials ranged from 8 to 16 per cent. of the total amount of heat supplied, an amount too great to be assumed as lost in conduction and radiation, but a second series of trials upon a larger engine gave more satisfactory results. Thus 26 per cent. appeared in indicated work, 32 per cent. in the jacket water, and 34.5 per cent. was measured in the exhaust calorimeter, leaving 7.5 per cent. unaccounted for, of which it is estimated that 1.5 per cent. passed up the chimney, leaving 6 per cent. for all other losses. Professor Hopkinson points out that this is as close an agreement as is obtained in steam engine tests in which the greatest precautions are taken to guard against heat losses, while with improvements in the details of the calorimeter design it is believed that still more accurate results may be expected. In the course of the discussion Professor Schröter, of Munich, stated that a similar apparatus in Germany enabled all but 2 or 3 per cent. of the heat in the balance to be accounted for.

An important point made by Professor Hopkinson was the fact that the measurement of the heat discharged with the exhaust might be more accurately made than the determination of the calorific value of the gas.

"One object of these trials was to ascertain whether a practical method of testing gas-engines for efficiency could be based on the calorimetry of the exhaust gases. At the present time manufacturers are mainly concerned with making their engines reliable; the thermal efficiency, being with any design far and away better than in the steam-engine, is a secondary consideration. But it cannot be doubted that in the future gas-engines will have to be as closely tested for efficiency as steam-engines now are. Now to measure the heat put into a large engine worked with producer gas is a very difficult and costly undertaking. The volume of gas is very great, and its quality may vary largely in the course of a day's trial. It seems that it may be easier and more accurate to measure the indicated work and the heat rejected, as is usually done in testing a steam-engine. One large part of the rejected heat—that is, the heat in the jacket-water—presents no difficulty; we have therefore only to measure the heat carried away in the exhaust gases."

While it may be of interest to find another method of determining the efficiency of the gas engine, it is undoubtedly far more desirable that all the elements in the computation shall be measured, in order that an accurate check may be kept upon the whole. For this reason it is to be hoped that the use of the exhaust calorimeter will not be permitted to prevent the efforts to determine the calorific value of the fuel, the measurement of the power, nor the independent measurement of the jacket losses, since any computation by difference should be avoided whenever possible, this rule holding good both for the mechanical and the chemical laboratory.

THE ENGINEERING INDEX

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The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 281
ELECTRICAL ENGINEERING 286
INDUSTRIAL ECONOMY 296
MARINE AND NAVAL ENGINEERING..... 298
MECHANICAL ENGINEERING 299
MINING AND METALLURGY............ 307
RAILWAY ENGINEERING 312
STREET AND ELECTRIC RAILWAYS...... 316

CIVIL ENGINEERING

BRIDGES.

Australia.

The Sydney Harbor Bridge, Australia. Illustrated description of the accepted design of a proposed bridge over Sydney Harbor. 1700 w. Eng News—Sept. 22, 1904. No. 65087.

Design.

Design in Relation to the Durability of Bridges. A discussion of this subject, illustrating by a comparison of two modern bridges across the Thames, England. 2200 w. Engr, Lond—Sept. 16, 1904. No. 65250 A.

Highway.

Highway Bridges. C. M. Canady. Considers some of the types and details which have claimed the attention of designers during the past twenty years. General discussion. 4500 w. Pro Engrs Soc of W Penn—June, 1904. No. 65050 D.

Mexico.

The Tula and the Chone River Bridges, Mexico. Illustrated descriptions. 1500 w. Eng Rec—Sept. 24, 1904. No. 65226.

Pittsburg.

The Erection of the Tenth Street Bridge, Pittsburg. An illustrated detailed description of methods used in erecting a bridge carrying highway and street car traffic across the Monongahela River. 2000 w. Eng Rec—Aug. 27, 1904. No. 64737.

Plate Girders.

Plate Girder Webs. A discussion of the best method of finding the right thickness for the web of any given girder. 5000 w. Engr, Lond—Sept. 9, 1904. No. 65041 A.

Reconstruction.

Bridge Renewal Under Unusual Conditions. Illustrates and describes the methods used in renewing the drawbridge on the New York, Chicago & St. Louis Ry. at Lorain, showing the difficulties of the work and how they were overcome. 1100 w. Eng News—Sept. 22, 1904. No. 65090.

The New Main Span of the Plattsmouth Bridge. An illustrated detailed description of improvements made in a bridge crossing the Missouri River in order to provide for heavier loads and increasing traffic. 2700 w. Eng Rec—Aug. 27, 1904. No. 64731.

The Reconstruction Works Upon the Mont Blanc Bridge at Geneva (Les Travaux de Réfection du Pont du Mont Blanc à Genève). George Autran. An illustrated account of the placing of a new superstructure upon the piers of the bridge over the Rhône. 1800 w. Schweiz Bauzeitung—Sept. 3, 1904. No. 65179 B.

Reinforced Concrete.

Reinforced Concrete Bridge Over the Jesenica near Reka (Betoneisenbrücke über den Jesenicabach bei Reka). Gustav Hermann. Illustrating the construction of a Melan arch of 19 metres span in Southern Austria. 2000 w. 3 plates. Oesterr Wochenschr f d Oeffent Baudienst—Sept. 10, 1904. No. 65189 D.

Reinforced Concrete Highway Bridges in New Jersey. Illustrates and describes bridges over the Passaic River in the vicinity of Paterson. 2500 w. Eng Rec—Sept. 10, 1904. No. 64935.

See also Civil Engineering, Construction.

Suspension.

The Bridges of the Haut-Ogoône Company in the French Congo (Les Ponts du Haut-Ogoône dans le Congo Français). Lieut. Col. Giselard. An account of the simple system of suspension bridges over the rivers on the route between Alembé and Lélédi. 3000 w. 1 plate. Génie Civil —Aug. 27, 1904. No. 65118 D.

The New Manhattan Bridge. A short sketch of the history of this bridge, with an illustrated description of the design as approved by the Municipal Art Commission. 1200 w. Archts' & Bldrs' Mag—Sept., 1904. No. 64891 C.

The Theory of the Stiffened Catenary with Increased Horizontal Tension (Beitrag zur Theorie der Versteiften Kette mit Aufgehobenem Horizontalzuge). Prof. Ramisch. A graphical and analytical study, showing the effect of temperature changes. 1800 w. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 13, 1904. No. 65186 D.

The Williamsburg Bridge over the East River, in New York (Die Williamsburg-Brücke über den East River in New York). K. Bernhard. A very fully illustrated account of the new bridge, showing its location and construction, with details of the erection. Two articles, 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 27, 1904. No. 65101 each D.

Uganda.

American Bridge Building in Equatorial Africa. An illustrated detailed description of the construction of the bridges on the Uganda Railway, in Central Africa. 3300 w. Eng Rec—Sept. 3, 1904. Serial. First part. No. 64811.

CONSTRUCTION.

Building Construction.

The Equipment and Construction of the Phipps Power Building at Pittsburg. Gerald E. Flanagan. Illustrated description of a building designed to furnish power in various forms from a central station to a group of buildings adjacent. 4000 w. Ir Trd Rev—Sept. 15, 1904. No. 64990.

The Phipps Power Building. Gerald E. Flanagan. An illustrated detailed description of a building and its equipment, designed to furnish power in various forms to a group of buildings adjacent. 4000 w. Pro Engrs' Soc of W Penn—Aug., 1904. No. 65055 D.

Columns.

Raising 90-Ton Columns at the Cathedral of St. John the Divine, New York City. Illustrations with brief description of the method used. 500 w. Eng News —Sept. 1, 1904. No. 64793.

Dams.

A Proposed Earth Dam with a Steel Core and a Reinforced Concrete Spillway at Ellsworth, Me. J. A. Leonard. Brief description, with illustrations. 400 w. Eng News—Sept. 22, 1904. No. 65089.

Timber Dam at the Outlet of Chesuncook Lake, Penobscot River. J. W. Tower. Illustrates and describes the construction. 800 w. Eng News—Sept. 1, 1904. No. 64795.

Ditcher.

The Buckeye Traction Ditcher. Frank

C. Perkins. Illustrated description of a labor-saving device, designed to cut trenches and ditches. 1500 w. Sci Am—Sept. 10, 1904. No. 64917.

Fireproofing.

Notes on Fireproofing City Buildings. Perez M. Stewart. Extracts from a paper on "The Fire Resistance of Modern High Buildings," read before the International Assn. of Fire Engineers, at Chattanooga, Tenn. Considers the horizontal, vertical and exposure hazards, substituting for wood, incombustible furnishings, etc. 3000 w. Engs News—Sept. 22, 1904. No. 65091.

Foundations.

Chicago Foundations. James N. Hatch. Describes the condition of the soil and the types of foundation which have become standard. Ills. 3000 w. Archts & Bldrs' Mag—Sept., 1904. Serial. 1st part. No. 64892 C.

Concrete Pile Foundations at Washington Barracks, D. C. Capt. John Stephen Sewell. Describes the foundation difficulties encountered and the means adopted for overcoming them. Ills. 2800 w. Eng Rec—Sept. 24, 1904. No. 65225.

Constructing the Foundations of the Trinity Building, New York. Illustrated description of difficult foundation work in the City of New York, adjacent to Trinity Church grounds, and to the elevated railway. 4000 w. Eng Rec—Sept. 3, 1904. No. 64815.

Derricks and Sheet Pile Drivers for Foundation Work. Illustrates and describes the foundation work of the new Trinity Building, in New York, and the machinery for meeting the difficulties. 2000 w. Eng Rec—Aug. 27, 1904. No. 64734.

Foundations of the Power House of the New York Rapid Transit R.R. Information concerning the massive foundations required to support a steel superstructure 125 feet high, containing a great amount of very heavy machinery. 1500 w. Eng Rec—Aug. 27, 1904. No. 64736.

Reconstruction.

Replacing Girders in a Lower Story of a High Office Building. Illustrated detailed description of work carried out in enlarging the N. Y. Times Building, on Park Row, New York. 3000 w. Eng Rec—Sept. 24, 1904. No. 65230.

Reinforced Concrete.

Considère's Theory of Reinforced Concrete in the Light of Recent Beam Tests. Reviews Mr. Considère's experiments and conclusions, and the light thrown on this subject by the recent tests of Prof. A. N. Talbot, and of Prof. F. E. Turneaure. 1600 w. Eng News—Sept. 15, 1904. No. 64983.

Flexure of Reinforced Concrete Beams. Arthur N. Talbot. A summary of tests made in the Laboratory of Applied Mechanics of the University of Illinois, discussing some of the analytical phases of the resistance of such beams to flexure. Ills. 7500 w. Jour W Soc of Engrs—Aug., 1904. No. 65095 D.

Reinforced Concrete. John Monash. Read before the Royal Victorian Inst. of Archts. An explanation of the principal characteristics of this construction, and some of its applications. 3000 w. Archt, Lond—Sept. 16, 1904. No. 65236 A.

Tests of Reinforced Concrete Beams. Prof. F. E. Turneaure. Read before the Am. Soc. for Test. Mat. Describes investigations made of the strength of beams reinforced by different methods and loaded in different ways. 2400 w. Eng Rec—Sept. 3, 1904. No. 64810.

Tests of the Siegwart Beam (Erprobung von Siegwart Balken). F. Schule. Describing tests of a special form of reinforced concrete beam upon a testing machine arranged for distributed transverse loads. 1000 w. Schweiz Bauzeitung—Aug. 27, 1904. No. 65178 B.

See also Civil Engineering, Bridges.

Roads.

Road Construction on the Island of Cyprus. Describes the making and maintenance of roads in an island where traffic is by diligences and vehicles not weighing much more than 2 tons when loaded. 1500 w. Eng Rec—Aug. 27, 1904. No. 64738.

Tunnels.

The First Street Tunnel at Washington. Begins an illustrated description of the construction work of the tunnels for the passenger trains of the Pennsylvania R. R. by which they will reach the new Union Terminal Station. 1600 w. Eng Rec—Sept. 3, 1904. Serial. 1st part. No. 64809.

The Simplon Tunnel (Le Tunnel du Simplon). Pierre de Blonay. A detailed account of the work from July 1, 1903, to June 30, 1904, with tables and diagrams of excavation, temperature, ventilation, drainage, etc. 4000 w. Bull Tech de la Suisse Rom—Sept. 10, 1904. No. 65185 D.

The Virginia Avenue Tunnel, Washington. Illustrated description of the construction. 2400 w. Eng Rec—Aug. 27, 1904. No. 64733.

Tunneling with a Shield in London Clay. H. A. Bartlett. Extract from a paper presented to the Inst. of Civ. Engrs., London. Illustrates and describes the work done by the shield and methods employed. 1500 w. R R Gaz—Vol. XXXVII. No. 14. No. 65001.

Wind.

The Tornado of August 20, 1904, at St. Paul, Minn. C. A. P. Turner. Illustrates and describes the effect on buildings and bridges. 1800 w. Eng News—Sept. 1, 1904. No. 64796.

MATERIALS OF CONSTRUCTION.

Bricks.

The Manufacture of Bricks from Destructor Clinker. Illustrates and describes the process of manufacture in the plant installed by the Woolwich Town Council in conjunction with their refuse destructor. 1000 w. Engr, Lond—Aug. 26, 1904. No. 64872 A.

Cements.

Hydraulic Limes and Grappier Cements. Edwin C. Eckel. Describes the manufacture and properties of these two cementing products which are closely allied to the natural cements. 2800 w. Munic Engng—Sept., 1904. No. 65048 C.

The Cement-Belt in Lehigh and Northampton Counties of Pennsylvania. F. B. Peck. Read before the Am. Chem. Soc. An illustrated description of the geological formations. 3000 w. Mines & Min—Sept., 1904. No. 64877 C.

Practical Cement Control. Dr. Charles F. McKenna. Condensed from a paper read before the Am. Soc. for Test. Mat. Applies principally to large works, giving specifications and methods of inspection. 2400 w. Eng Rec—Aug. 27, 1904. No. 64732.

MEASUREMENT.

Surveying.

Results Recently Obtained by Métrophotography (Sur Différents Resultats Récemment Obtenus par la Métrophotographie). A. Laussedat. Showing the excellent results in the study of topography by the aid of the Pulfrich stereo-comparator. 1000 w. Comptes Rendus—Aug. 8, 1904. No. 65123 D.

MUNICIPAL.

Pavements.

Brick Pavements in America. Ira O. Baker. Describes the making and testing of the bricks used, the road construction, filling, &c., and gives information as to their merits and cost. Ills. 4200 w. Public Works—Sept. 15, 1904. No. 65033 D.

Refuse Disposal.

Description of Refuse Destructor and Electrical Power Generating Station in Course of Erection at Saltley. D. J. Roberts. Illustrates and describes this combined scheme for cremating ordinary refuse and utilizing the heat for raising steam for generating electricity for traction and lighting purposes. 3800 w. Elec Engr, Lond—Sept. 9, 1904. No. 65028 A.

The New Garbage Cremator at Toronto. Illustrated description of a new destructor which combines the Mann, the Thackeray, and the Dixon systems. 1000 w. Eng Rec—Sept. 10, 1904. No. 64940.

The Riker's Island Refuse Conveyor Plant. The refuse from Manhattan, New York, exclusive of garbage, is being used to extend the area of this island, and the plant which has been installed for unloading and distributing the material is illustrated and described. 1500 w. Eng Rec—Sept. 17, 1904. No. 65017.

Sewage.

Bacterial Sewage Disposal at Ash, England. Describes these works, which are of interest on account of the conditions under which they were built. 2200 w. Eng Rec—Sept. 24, 1904. No. 65231.

Sewers.

An English Fan System of Sewer Ventilation. From a paper by E. George Mawbey, read before the English Assn. of Munic. and Co. Engrs. Describes the writer's experience with the new system of sewer ventilation devised and patented by Messrs. Shone & Ault, with satisfactory results. 2000 w. Eng Rec—Aug. 27, 1904. No. 64735.

Street Cleaning.

Street Cleaning in German Cities. Howard Woodhead. Describes the attention given to this branch, the enforced regulations for non-littering of streets, the removal of refuse, and the smooth pavements which make thorough cleaning possible. 2500 w. Munic Jour & Engr—Sept., 1904. No. 64908 C.

WATER SUPPLY.

Croton Dam.

Completing the New Croton Dam. Illustrations, with description of construction work on the dam for the New York water supply. 1600 w. Sci Am—Sept. 24, 1904. No. 65083.

Recent Progress on the New Croton Dam. An illustrated account of work on this dam which is to impound an additional water supply of 32,000,000,000 gals. for New York City. 3800 w. Eng Rec—Sept. 10, 1904. No. 64939.

Distribution.

Multiple Zone Distribution for Municipal Water Supply (Mehrfache Versorgungszonen für städtische Wasserleitungen). Rudolf Müller. Showing the advantages of dividing the area into several zones of various levels, with supplies of corresponding pressures. 2000 w. Oesterr Wochenschr f d Oeffent-Baudienst—Aug. 20, 1904. No. 65188 D.

Filters.

The Open Sand Filters for the Providence Water-Works. An illustrated detailed description of this plant. 3000 w. Eng Rec—Sept. 24, 1904. Serial. 1st part. No. 65224.

Irrigation.

The Irrigation Works of the Modesto and Turlock Districts, Cal. The first of a series of illustrated articles giving a descriptive account of the engineering work. 2000 w. Eng Rec—Sept. 17, 1904. Serial. 1st part. No. 65014.

Komotau.

The Water Supply of the City of Komotau (Die Wasserversorgung der Stadt Komotau). J. A. Spitzer. Illustrating and describing the construction of the dam, aqueduct, and filter plant for the city of Komotau, in Bohemia. Two articles, 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 12, 19, 1904. No. 65150 each D.

Obstructions.

Incrustations, Deposits and Organic Growths in Pipes and Other Water Conduits. Excerpt from a paper by James C. Brown, presented to the Inst. of Civ. Engrs. Considers incrustations in unprotected iron pipes, and deposits and growths depending on the composition of the water. 1200 w. Eng News—Sept. 22, 1904. No. 65088.

Reservoirs.

Cleaning a Water-Works Reservoir by Dredging. F. B. Marsh. Describes apparatus and methods used in cleaning reservoir No. 1, in Pittsburg, and the cost. 1200 w. Eng Rec—Sept. 3, 1904. No. 64814.

Supervision.

The Supervisory Control of Water Supplies in Great Britain. James Robert Kaye. Read before the Sanitary Inst. in Glasgow. A discussion of the various proposals for supervisory control, especially describing the practice of the Derwent Valley Water Board. 2500 w. Eng Rec—Sept. 17, 1904. No. 65015.

Water Treatment.

Copper Sulphate Treatment of Lakes Clifton and Montebello, Baltimore Water Works. Alfred M. Quick. Two low-service storage reservoirs became troubled with algae, and the treatment given and method of application is described. 1500 w. Eng Rec—Sept. 24, 1904. No. 65229.

The Use of Sulphate of Copper for the Destruction of Algae in Reservoirs (Emploi der Sulfate de Cuivre pour la Destruction des Algues dans les Réservoirs d'Eau Potable). A review of the proposed method of purifying water by sulphate of copper. 2000 w. Génie Civil—Aug. 13, 1904. No. 65115 D.

WATERWAYS AND HARBORS.

Canal Lift.

A novel Canal Lift at Foxton. Illustrates and describes a system devised by Gordon & James B. Thomas, of England, for abolishing locks and raising and lowering boats by mechanical means. 1500 w. Sci Am—Sept. 3, 1904. No. 64758.

Cape Town.

Cape Town Harbor Works. R. H. Hammersley-Heenan. An introductory review of the early history of this southern point of the African Continent, and early engineering work there, with illustrated description of recent work. 7400 w. Public Works—Sept. 15, 1904. No. 65032 D.

Flow.

Recent Russian Studies of Flow in Rivers. Translation of interesting parts of the work describing Professor Tiapkin's hydraulic experiments. 3300 w. Eng News—Sept. 1, 1904. No. 64794.

Nile.

Nile Irrigation. Sir Hanbury Brown. A discussion of the problem of providing for the continued development of Egypt and the reclamation of the Soudan at the same time, based on the recent report of Sir William Garstin. Map. 6000 w. Engr, Lond—Sept. 9, 1904. Serial. 1st part. No. 65039 A.

The Irrigation Development of Egypt—A Huge Project. Outlines the scheme formulated by Sir William Garstin for improving the channels of the White Nile and the Blue Nile, the Nile Delta, &c., and so rendering fertile thousands of acres of land now sterile. 1200 w. Sci Am Sup—Sept. 10, 1904. No. 64922.

River Improvement.

Navigation on the Rivers of the Pacific Northwest. The work of the government in improving the Columbia, Snake and other rivers of Oregon, Washington and Idaho, with illustrations of the type of steamboats employed on these streams. 1500 w. Naut Gaz—Sept. 8, 1904. No. 64932.

Zeebrugge.

The Harbor Works at Zeebrugge (De Havenwerken te Zeebrugge). W. Meijer Timmerman Thijssen. Showing the new curved breakwater, and channel through the bar at the port of Zeebrugge, Holland. 2000 w. De Ingenieur—Aug. 13, 1904. No. 65184 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Alaska.

Building the Alaskan Telegraph System. Capt. William Mitchell. A description of some of the difficulties met and conquered. 3300 w. Nat Geog Mag—Sept., 1904. No. 64893 C.

Automatic.

The Automatic v. the Manual Telephone Exchange. Kempster B. Miller. An examination of some of the phases as they appear to the writer, with comments. 3700 w. Int Elec Cong of St. Louis–Sept., 1904. No. 65289 D.

The Automatic Telephone System at Los Angeles, Cal. P. K. Higgins. Illustrated description of the new equipment of the Home Telephone and Telegraph Company. 3800 w. Elec Rev, N Y—Sept. 3, 1904. No. 64828.

Battery System.

Features of the Dunbar Two-Strand Common-Battery Systems. Prof. J. C. Kelsey. Briefly considers the features of the various commercial systems and the advance made by the Dunbar systems. Ills. 3000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65293 D.

Cables.

A New Danger to Lead-Covered Aerial Cables. John Hesketh. Describes trouble caused by an insect in Queensland which attacks the telephone cables. Ills. 2500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65288 D.

Some Recent Long-Distance Submarine Telephone Cables. F. Breisig. Abstract of a paper read before the Elektrotechnischer Verein of Berlin. An illustrated article describing the Fehmarn-Lolland, the Greetsiel-Borkum, and the Cuxhaven-Heligoland cables. 2000 w. Elect'n, Lond—Sept. 2, 1904. No. 64959 A.

Submarine Cables (Les Cables Sous-marins). G. Couraud. Describing modern methods of cable laying, illustrating the practice of different countries. Serial, Part I. 3000 w. Revue Technique—Aug. 25, 1904. No. 65128 D.

The Alternating-Current Theory of Transmission-Speed over Submarine Telegraph Cables. Prof. A. E. Kennelly. Mathematical treatment, showing the importance of the receiving-end impedance. Also bibliography and appendix, with table of hyperbolic functions of semi-imaginary quantities. 9000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65331 D.

Double Service.

Simultaneous Telegraphy and Telephony. Joseph Hollos. Outlines the principles which were followed in the formation of the Hungarian system, which shows good results. 1500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65282 D.

The Malcotti Telecryptograph for Telegraphing upon Telephone Lines. Emile Guarini. Remarks on recent efforts to popularize the telegraph for private use, and to insure privacy on telephone lines, with illustration and information concerning the instrument which claims to have solved the problem. 1700 w. Sci Am—Sept. 17, 1904. No. 64985.

Exchanges.

A Progressive Western Telephone Exchange. H. K. Sprague. An illustrated description of the new telephone exchange at Boulder, Colorado. 3800 w. Am Elect'n—Sept., 1904. No. 64843.

Theory of Telephone-Exchange Development. G. de la Touanne. A summary of the principal commercial questions met in starting a new telephone exchange. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65286 D.

The New Telephone Exchange at Budapest (Die Neue Telephoncentrale in Budapest). P. von Szalay. With views of the building, together with switchboard and connections made by the Western Electric Co. after a competition with Swedish, French, German, and American firms. 2000 w. Elektrotech Zeitschr—Sept. 8, 1904. No. 65162 B.

Fire Alarm.

Electric Fire Alarm System for Warehouses and Theatres (Elektrische Feuer-Alarmanlagen in Warenhäusern und Theatern). K. Miram. The apparatus sounds the alarm and indicates the nearest exits when the alarm button at any point is pressed. 2000 w. Elektrotech Zeitschr—Sept. 15, 1904. No. 65166 B.

Japan.

Telegraphy and Telephony in Japan. Saitaro Oi. Reviews the development in Japan, and the present situation. Ills. 4300 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65280 D.

Military Service.

Signal Service in Modern Warfare. M. C. Sullivan. Describes methods used by the Japanese army in the war now in progress, especially the extensive use of the telephone. Ills. 1500 w. Sci Am—Sept. 10, 1904. No. 64920.

The Telegraph, Telephone and Cable in War. Maj. Samuel Reber. A general description of the service and its value in modern warfare, with review of its early history. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65291 D.

Multiple Transmission.

Harmonic Telegraph. Prof. Ferdinando Lori. Brief explanation of a multiple transmission system based on this principle. 500 w. Int Elec Cong of St. Louis —Sept., 1904. No. 65287 D.

Printing Telegraphs.

Modern High Speed Printing Telegraph Systems. J. C. Barclay. General discussion with brief descriptions of the Murray, Rowland, and Buckingham systems. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65294 D.

Printing Telegraphy. Dr. Louis M. Potts. Treats of the various essential principles involved in the systems which have been shown to be of practical value. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65281 D.

The Keyboard of the Hughes Telegraph (Die Klaviatur des Hughes-apparates). G. Conradt. Discussing the arrangements of the keyboard of the Hughes printing telegraph to give the best efficiency in different languages. 2000 w. Elektrotech Zeitschr—Aug. 25, 1904. No. 65158 B.

Relays.

The Problem of the Telephone Relay. Dr. John Trowbridge. An account of an instrument produced by the writer, and the character of its working. 1000 w. Elec Rev, N Y—Sept. 10, 1904. No. 64946.

Space Telegraphy.

A New System for Securing Secrecy in Wireless Telegraph Signaling. Emile Guarini. Discusses the transmitting and receiving system devised by M. Blondel, in France, and Prof. Artom, in Italy. 2200 w. Sci Am Sup—Sept. 17, 1904. No. 64988.

Electrolytic Receivers in Wireless Telegraphy. Dr. Lee de Forest. Briefly reviews the field of cohering indicators of electric waves, and calls attention to researches leading to forms of sensitive receivers, adaptable to most of the demands of wireless telegraphy. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65290 D.

The Present State of Wireless Telegraphy. Prof. J. A. Fleming. A broad general statement of the present state of the art. 12000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65284 D.

The Tuning of Space Telegraphic Transmitters (Die Abstimmung Funkentelegraphischer Sender). A. Slaby. Discussing methods of increasing the energy capacity of the transmitter wires, and means of regulating the wave-lengths emitted. Two articles, 10000 w. Elektrotech Zeitschr—Aug. 18, Sept. 8, 1904. No. 65153 each B.

Telegraph Poles.

Some Causes of the Unequal Durability of Telegraph Poles (Ueber einige Ursachen Ungleicher Dauerhaftigkeit der Telegraphstangen). Karl Havelik. Showing the influence of the character of the wood, the method of preparation, and the system of construction, upon the durability of telegraph poles. 5000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Aug. 20, 1904. No. 65187 D.

Telegraphy.

Rapid Telegraphy. Patrick B. Delany. Defines the term as designated by usage, and reviews the various systems, their limitations, and related matters. 5700 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65283 D.

Telephony.

High-Frequency Telephone Circuit Tests. Dr. A. E. Kennelly. Describes certain apparatus constructed for the purpose of measuring the alternating-current strength, at telephonic frequencies, received at the distant end of a telephone circuit, with a definite e. m. f. impressed on the sending end. Ills. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No 65295 D.

Loaded Telephone Lines in Practice. Dr. Hammond Vinton Hayes. A brief statement of the results obtained by the use of loaded coils on many of the telephone circuits of the Bell companies. 3000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65292 D.

The Telephone Problem in Large Cities. F. J. Dommerque. Considers the best service can be rendered in an exchange without trunking, and that the quality deteriorates with increasing percentage of trunking. 3000 w. Int Elec Cong of St. Louis, Sept., 1904. No. 65285 D.

DISTRIBUTION.

Autotransformer.

The Theory of the Autotransformer (Die Theorie des Autotransformators). Dr. Ed. Slovsa. A discussion of the action of transformers in which the change of pressure is effected by the use of a single bobbin system. Serial, Part I. 2500 w. Zeitschr f Elektrotechnik—Sept. 18, 1904. No. 65173 D.

Cables.

Eddy-Current Losses in Three-Phase

Cable Sheaths. M. B. Field. Read before the British Assn. Gives calculations of self-induced eddy currents and mutually induced eddy currents. 4000 w. Elec Engr, Lond—Sept. 16, 1904. No. 65240 A.

Experiments on Sheath Losses of Three-Core Cables. J. T. Morris. An account of experiments carried out by the author to determine experimentally the magnitude of some of these losses in cables conveying polyphase currents. 3000 w. Elect'n, Lond—Sept. 2, 1904. No. 64958 A.

Conductors.

Computations of the Influence of Capacity, Induction and Resistance upon Aerial or Subterranean Conductors (Berechnung der Einflusse von Kapazität, Induktion, und Resistanz auf Ober oder Unterirdischen Leitungen). E. W. Ehnert. Containing an extensive series of examples relating to various problems with polyphase currents. Three articles, 6000 w. Zeitschr f Elektrotechnik—Sept. 4, 11, 18, 1904. No. 65171 each D.

Controllers.

Notes on the Design of Controllers (Weitere Beiträge zum Entwurf von Kontrollern). Robert Edler. Discussing especially the application of cams in the design of controllers for heavy hoisting and conveying machinery. Two articles, 6000 w. Zeitschr f Elektrotechnik—Aug. 21, 28, 1904. No. 65169 each D.

Cut-Out.

Circuit-Breakers. W. M. Scott. A discussion of reverse current circuit-breakers and their operation, applications, &c. Ills. 5500 w. Jour Fr Inst—Sept., 1904. No. 65063 D.

Direct Current.

The Direct-Current Distributing Systems of American Cities. Alex Dow. Describes the electric distribution system which is commonly in use in the larger American cities, stating the reasons for the adoption and retention of the system, and in a sense justifying the methods of the larger electric light companies. 11000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65307 D.

Fuses.

Observations with the Oscillograph upon the Time Required for the Melting of Fuses (Ueber den Zeitlichen Verlauf des Schmelzstromes von Sicherungen Beobachtet mit dem Oscillographen). E. Oelschläger. Giving diagrams showing the time required for melting safety fuses with various currents. 2500 w. Elektrotech Zeitschr—Sept. 1, 1904. No. 65160 B.

High Tension.

Protection and Control of Large High Tension Alternating-Current Distribution Systems. George N. Eastman. Examples and conditions presented refer to the system of the Chicago Edison Company and Commonwealth Electric Company, discussing the protection needed. Ills. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65298 D.

70,000-Volt, Direct-Current Tests Made at Genoa, Switzerland. B. F. Hirschauer. An account of important experiments with high voltage distribution on the direct-current system which have been carried out by M. Réné Thury. 4000 w. Elec Rev, N Y—Sept. 24, 1904. No. 65233.

Net-Works.

The Distribution of Voltage and Current in Closed Conducting Net-Works. Prof. Clarence Feldmann and Josef Herzog. A demonstration of some simple theorems which explain the manner of dealing with net-works of conductors from the standpoint of the electrical engineer, greatly restricting the application of mathematics. 3600 w. Int Elec Cong of St. Louis—Sept., 1904. No. 64276 D.

Switch.

The Automatic Transformer Switch (Der Automatische Transformatorenschalter). J. Schmidt. Describing a device for automatically cutting out the transformers of a distribution system as the demand falls off. 6000 w. Elektrotech Zeitschr—Sept. 15, 1904. No. 65165 B.

Systems.

Distributing Systems from the Standpoint of Theory and Practice. Philip Torchio. A review of the systems of distribution, studying the problem by assuming a concrete case, describing the possible lay-outs, &c. Ills. 11000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65308 D.

Transformers.

Notes on Experiments with Transformers with Very High Potentials. Prof. Harold B. Smith. Description, with illustrations, of a transformer made under the writer's direction, with a statement of the experience with it for the past six years. 2000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65273 D.

Underground.

Underground Electrical Construction. Louis A. Ferguson. Describes particularly the drawing in system of cables and conduits, their operations, &c. Ills. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65296 D.

ELECTRO-CHEMISTRY.

Anodes.

The Electrical Properties of the Films

that Form on Aluminum Anodes. William Roy Mott. Considers these insulating films as regards their specific resistance, insulating strength, and specific inductive capacity. 4000 w. Elec Chem Ind—Sept., 1904. No. 64805 C.

Battery.

How to Make a High-Voltage Testing Battery. George T. Hanchett. Directions with illustrations. 1000 w. Am Elect'n—Sept., 1904. No. 64847.

Carbon Cell.

The Carbon Cell Considered as a Gas Battery (Das Kohlenelement eine Knallgaskette). F. Haber and L. Bruner. A study of the action of the cell consisting of carbon and iron plates in fused soda. 7500 w. Zeitschr f Elektrochemie—Sept. 9, 1904. No. 65176 D.

The Carbon Cell. Prof. Dr. F. Haber and Dr. L. Bruner. Theory and record of experiments with cells having carbon and iron or platinum electrodes and sodium hydrate electrolyte. 2500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65322 D.

Cells.

A Study of the Materials Used in Standard Cells and Their Preparation. George A. Hulett. Considers mercurous sulphate and standard cells. Prof. Henry S. Carhart discusses the preparation of materials and construction of cells. 5700 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65330 D.

Chlorine.

Chlorine in Metallurgy. James Swinburne. Describes a process depending on the action of chlorine. The principle is the treating of sulphide ores, without previous roasting, with chlorine, so as to form chlorides of the metals, the sulphur being liberated as such. The chlorides are then electrolyzed, yielding metals and recovering the chlorine. 1600 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65327 D.

Some Notes on the Uses of Electrolytic Chlorine. F. Winteler. Gives suggestions for the manufacture of products other than bleaching powder to utilize the excess of chlorine. 3300 w. Elec Chem Ind—Sept., 1904. No. 64802 C.

Conduction.

Electrolytic Conduction. Prof. Joseph W. Richards. The object of the paper is to present the thesis that, as far as the conduction of electricity through the body of the conductor is concerned, there is, as far as can be determined, complete identity between metallic conductors and so-called electrolytic conductors. 2200 w. Int Elec Cong of St. Louis—Sept, 1904. No. 65319 D.

Electrical Furnaces.

Some First Principles of Electrical Resistance Furnaces. F. A. J. Fitz Gerald. A study of the principles of these furnaces, their construction and manipulation. 3500 w. Elec Chem Ind—Sept., 1904. Serial. 1st part. No. 64803 C.

Electrolysis.

Electrolysis and Catalysis. Prof. Dr. W. Ostwald. Shows what a very essential and important part the catalyzers are able to play in electrolytic action. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65324 D.

The Energon Theory of Electrolysis (Elektrolyse nach der Energon Hypothese). A. Reuterdahl. With diagrams explaining the dynamic theory of electrolytic dissociation. 2500 w. Elektrochemische Zeitschr—Sept., 1904. No. 65175 G.

Electro-Metallurgy.

The Electro-Metallurgy of Iron and Steel. A. F. Schneider. Reviews some of the processes which have been successful and are now in use, illustrating and comparing them. 1500 w. Min Mag—Aug., 1904. No. 65202 C.

Electroplating.

The Chemistry of Electroplating. Prof. Wilder D. Bancroft. Shows that a study of chemical reactions and chemical analogies will at least give the outlines of a theory of electroplating. 2800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65321 D.

Ferro-Alloys.

The Manufacture of Ferro-Alloys in the Electric Furance. George P. Scholl. Deals only with such ferro-alloys as are manufactured on an industrial scale in practice. The present article reviews the history of their manufacture. 2800 w. Elec Chem Ind—Sept., 1904. Serial. 1st part. No. 64804 C.

Metals.

The Electrochemical Series of the Metals. Prof. Louis Kohlenberg. A detailed study of the differences of potential between metals and solutions, showing that it may vary greatly with a change in the solute as well as with a change in the solvent. 2500 w. Int Elec Cong of St. Louis—Sept., 1904—No. 65323 D.

Nitrates.

Electrical Extraction of Nitrogen from the Air. J. Sigfrid Edstrom. Reviews the methods proposed for extracting the nitrogen from the air, especially describing the new process by Prof. C. Birkeland and S. Eyde, of Christiana. Ills.

2800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 64328 D.

Sodium.

The Manufacture of Sodium by the Becker Process. C. F. Carrier, Jr. An illustrated critical review of this process as described by the inventor. 2000 w. Elec Chem Ind—Sept., 1904. No. 64807 C.

Storage Battery.

The Jungner Nickel-Iron Accumulator and its Origin. M. V. Schoop. Translated from the *Centralblatt für Accumulatoren Technik und Verwandte Gebiete.* An illustrated account of Jungner's work in this field. 3500 w. Sci Am Sup—Sept. 17, 1904. No. 64989.

The Present Status of the Edison Storage Battery. A. E. Kennelly and S. E. Whiting. A brief synopsis of the results obtained with this battery up to the present date. Ills. 4800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65329 D.

Zinc Sulphides.

Electrolytic Production of Zinc and Lead from Complex Sulphide Ores. Charles H. Burleigh. On the treatment of refractory zinc sulphides, giving facts which have been tested and proved on a commercial scale. 3000 w. Elec Chem Ind—Sept., 1904. No. 64806 C.

ELECTRO-PHYSICS.

Coherers.

Coherer Action. Dr. K. E. Guthe. Reviews experimental investigations made and the theories proposed for an explanation of coherer action, and formulates a theory, attempting to show its agreement with phenomena observed. Also bibliography. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65344 D.

Compressible Atoms.

The Relation of the Hypothesis of Compressible Atoms to Electrochemistry. Prof. Theodore William Richards. Shows that this hypothesis, dealing as it does with very intimate relations of energy and material, is not without suggestiveness to the electrochemist and electrician. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65320 D.

Condensation.

Condensation Nuclei. Prof. C. T. R. Wilson. An explanation and discussion of the theory of condensation of water vapor on ions. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65346 D.

Conductivity.

Effect of the Atmosphere on the Conductivity of Aluminium Alloys. Ernest Wilson. Read at the British Assn. An account of experimental investigations. 700 w. Elect'n, Lond—Aug. 26, 1904. No. 64860 A.

Electric Conduction in Metals, from the Standpoint of the Electronic Theory. Prof. P. Drude. A treatment of this subject containing some hitherto unpublished ideas. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65345 D.

The Electrical Conductivity of Gases. Prof. Percival Lewis. Discussion of observed phenomena and of theories, principally ionization. 5400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65333 D.

Dielectrics.

On Electrostriction. Prof. Louis Trenchard More. An account of new experiments, describing the apparatus used, giving results. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65342 D.

Electric Waves.

The Unobtained Wave Lengths Between the Longest Thermal and the Shortest Electric Waves Yet Measured. Prof. E. F. Nichols. A brief survey of present knowledge suggesting several experiments directed toward the production and measurement of short electric waves. 1200 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65338 D.

Fogs.

Dispelling Fog by Electricity—An Experimental Proof. A. Frederick Collins. An account of the experimental investigations in this field, made by Sir Oliver Lodge. Ills. 2000 w. Sci Am—Sept. 3, 1904. No. 64760.

Heat Equivalent.

The Mechanical Equivalent of Heat Measured by Electrical Means. Prof. Howard T. Barnes. Discusses the most probable value of the mechanical equivalent in terms of the generally accepted values of the electric unit. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65336 D.

Holtz Machine.

The Priority of Invention of the Double Plate Influence Machine (Zur Priorität der Erfindung der Influenzmaschine mit Doppelter Drehung). Dr. W. Holtz. An account of the development of the static electrical machine, with especial reference to the form employing two plates revolving in opposite directions. 2000 w. Elektrotech Zeitschr—Aug. 18, 1904. No. 65155 B.

Insulation.

On Insulation. Discusses some of the conditions which have to be fulfilled by a good insulator, and the tests that should be made. 3500 w. Elec Engr, Lond—Sept. 16, 1904. No. 65242 A.

Ionization.

The Theory of Ionization by Collision. Prof. J. S. Townsend. Describes this theory in order to explain some of the phenomena which occur in the development of the large currents in a gas. 5800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65339 D.

Magnetism.

Energy Losses in Magnetizing Iron. W. M. Mordey and A. G. Hansard. Read before the British Assn. A report of investigations made and their results. 2500 w. Elec Engr, Lond—Aug. 26, 1904. No. 64863 A.

On Magnetostriction. Prof. H. Nagaoka. A brief survey of the experimental knowledge on this subject, including some new results. 4400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65343 D.

The Magnetic Effect of Moving Charges. Dr. Harold Pender. Considers the experimental evidence we have in favor of the assumption that an electric charge in motion produces a magnetic field, shows how the evidence has been obtained, and points out a few of the difficulties which have had to be overcome. 5000 w. Int Elect Cong of St. Louis—Sept., 1904. No. 65340 D.

Radioactivity.

Concerning Natural Radioactivity of the Atmosphere and the Earth. J. Elster and H. Geitel. A short review of investigations in this field and remarks on the importance of the discoveries. 2000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65278 D.

On the Radioactivity of Mineral Oils and Natural Gases. Prof. J. C. McLennan. Record of experiments, with tables and diagrams. Ills. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65335 D.

The Radioactive Atom (Das Radioaktiv Atom). A. Reuterdahl. A brief examination of the relation of radioactivity to the atomic theory of matter. 2500 w. Elektrochemische Zeitschr—Sept., 1904. No. 65174 G.

Rectifiers.

Electrolytic Rectifiers—An Experimental Research. Albert Nodon. An account of a series of researches conducted by the writer at the Sorbonne and the Collège de France. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65279 D.

Reluctance.

The Magnetic Reluctance of Air Cores in Short Coils. W. M. Thornton. Gives an account of experiments undertaken to determine the constants for coils of common proportions, the thickness and length of the windings of which placed them beyond ordinary mathematics. 1100 w. Elect'n, Lond—Sept. 16, 1904. No. 65246 A.

Spectrum Analysis.

Spectra of Gases at High Temperatures. Prof. John Trowbridge. Gives interesting facts obtained in researches to obtain a new series of hydrogen lines which might manifest themselves at high temperatures. A study of discharges of electricity in rarified gases. 3000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65337 D.

GENERATING STATIONS.

Alternating Currents.

The Computation of Alternating Currents without the Assumption of a Constant Coefficient of Self-Induction (Die Berechnung von Wechselströmen ohne Annahme Konstanter Selbstinduktionskoeffizienten). F. Spielmann. An elaborate mathematical treatment, including variable coefficients for self-induction. 2000 w. Zeitschr f Elektrotechnik—Aug. 14, 1904. No. 65168 D.

Armatures.

The Design of Armature Coils. Gives formulas intended for use after the electrical design of the machine has been completed, except the final shaping of the core, so that they may properly overlap. 600 w. Elec Wld & Engr—Sept. 17, 1904. No. 65047.

The Distribution of Magnetic Induction in Multipolar Armatures. W. M. Thornton. Read before the British Assn. A study of the effect of pole spacing, the length of the air-gap, the flux density within it, and the radial depth of the core upon the flux density in the core. Ills. 2200 w. Elect'n, Lond—Aug. 26, 1904. No. 64859 A.

Compounding.

Recent Developments in Compounded Alternators with Alternating-Current Self-Excitation. Alexander Heyland. An illustrated explanation of the present construction of the machines. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65271 D.

Converters.

Rotary Converters and Motor Generator Sets. William C. L. Eglin. A description and comparison. 2400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65301 D.

Day Loads.

A Day Load as a Factor in Central Station Earning Capacity. Lehman B. Hoit. Read before the Ohio Elec. Lgt. Assn. A brief consideration of some of the essential features of electric power, transmission, and the comparative relations of costs, returns and load factor. 2000 w. Elec Rev, N Y—Sept. 10, 1904. No. 64943.

Dynamos.

Management of Dynamos. Directions for properly caring for dynamos, especially the magnet winding, terminals and commutator. 3000 w. Mech Engr—Sept. 3, 1904. No. 64956 A.

The Design of Dynamos. Gives mathematical methods of obtaining dimensions. 900 w. Elec Rev, Lond—Sept. 16, 1904. No. 65244 A.

Exposition.

The Electric Generating Plants at the St. Louis Exposition (Die Stromerzeugungsanlage auf der Weltausstellung in St. Louis). Clarence Feldmann. A description of the various generating sets, forming exhibits, and furnishing current for the St. Louis Exposition. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1904. No. 65111 D.

The Power Plant of the St. Louis Exhibition. Illustrated detailed description of the plant furnishing electric current for the various lighting and power purposes. 4800 w. Eng News—Sept. 15, 1904. No. 64980.

Gas-Plants.

A Gas-Driven Electric Light and Traction Plant. Arthur H. Allen. An illustrated detailed description of the Walthamstow Electricity Works in England. 4500 w. Public Works—Sept. 15, 1904. No. 65034 D.

Gas and Power Engineering Development in Monterey County, Cal. George P. Low. An illustrated account of the upbuilding, growth, development, and engineering features of the Salinas and Monterey properties of the Monterey County Gas and Electric Company of Monterey, California. 10000 w. Jour of Elec—Sept., 1904. No. 65254 C.

Humming.

The Humming of Electrical Machines. J. Fischer Hinnen, in the *Zeitschrift für Elektrotechnik.* Describes how absolutely silent running may be secured. 1400 w. Elec Engr, Lond—Sept. 9, 1904. No. 65027 A.

Hydro-Electric.

Electricity from Water Power. A. A. Campbell Swinton. Read before the British Assn. A review of what has been accomplished in hydro-electric engineering. 4400 w. Elec Engr, Lond—Aug. 26, 1904. No. 64862 A.

The Dan River Power & Manufacturing Company's Plant. An illustrated account of the construction of a complete manufacturing property, including a cotton factory of 43,000 spindles, at Danville, Va. 3500 w. Eng Rec—Sept. 3 1904. No. 64818.

The Glommen Hydraulic Power Works. Particulars from a detailed account by T. Kinbach, in the *Zeitschrift des Vereines deutscher Ingenieure.* Illustrates and describes a plant for the distribution of electrical energy for power and other uses in Christiania, and neighboring towns in Norway. 2500 w. Engr, Lond—Aug 26, 1904. No. 64870 A.

The Guanajuato Hydro-Electric Transmission. Robert McF. Doble. Read before the Pacific Coast Elec. Trans. Assn. Illustrated detailed description of a notable hydro-electric development and high potential long-distance transmission, recently completed in Mexico. 7500 w. Jour of Elec—Sept., 1904. No. 65253 C.

The Hydro-Electric Station at Bogota. A. Steens. Illustrated description of an interesting station, 8,300 ft. above the sea level. 1600 w. Eng Rec—Sept. 3, 1904. No. 64817.

The Northern California Power Company's Systems. An illustrated detailed description of the Volta hydro-electric plant of this company. 3500 w. Elec Wld & Engr—Sept. 10, 1904. Serial. 1st part. No. 64947.

The Puget Sound Power Company. Describes the interesting features of these works in the State of Washington, U. S. A., to furnish power for Seattle and Tacoma. 2500 w. Engr, Lond—Sept. 2, 1904. Serial. 1st part. No. 64963 A.

The Rauris-Lend Electric Power Station (Die Elektrische Kraftübertragung Rauris Lend). H. Spyri. Describing the electric plant of the Austrian branch of the Neuhausen Aluminum Company, near Gastein, in the Tyrol. Two articles. 2500 w. Schweiz Bauzeitung—Aug. 6, 20, 1904. No. 65183 each B.

The Waipori Falls Electric Power Company's Project. Illustrations with description of the manner of carrying out this project of supplying electric current hydraulically developed in New Zealand. 1800 w. N Z Mines Rec—June 16, 1904. No. 64952 B.

Types of Large Water-Power Installations. Dr. F. A. C. Perrine. An interesting review of the development of the transmission and distribution of the power of water-falls, the effect on industry, describing typical plants. 3300 w. Cent Sta—Sept., 1904. No. 64924.

Isolated Plant.

The Daniels & Fisher Power Plant in Denver. Howard S. Knowlton. Illustrates and describes the isolated plant of a large department house. 3000 w. Eng Rec—Sept. 3, 1904. No. 64819.

The Mechanical and Electrical Equipment of the Hotel Astor. Illustrated detailed description. 1800 w. Elec Rev, N Y—Sept. 17, 1904. No. 65012.

Location.

Location of Electric Stations. Alton D. Adams. Reviews the practice of early plants and the movement later toward cheap land with free condensing water and direct boat or rail transportation. 3700 w. Elec Wld & Engr—Sept. 3, 1904. No. 64833.

Regulation.

Calculation of Alternator Regulation. C. E. Canfield. Describes methods for calculating the value of the armature reaction and inductive reactance and for treating the quantities when so found. Also editorial. 4000 w. Elec Wld & Engr—Sept. 3, 1904. No. 64832.

The Regulation of Alternators. D. B. Rushmore. A summary of work done and methods used for determining regulation, and the results of tests on differing types of machines. Ills. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65277 D.

Station.

The Broad Street Station of the Citizens' Light, Heat & Power Company, Johnstown, Pa. Illustrated detailed description of this station and its equipment. 2000 w. Power—Sept., 1904. No. 64754 C.

Switchboards.

The Traffic Design of Central Office Switchboards. A. Dallam O'Brien. Discusses the features that must be carefully considered in providing for the requirements of a proposed installation from a traffic standpoint. 3000 w. Am Elect'n —Sept., 1904. No. 64846.

Tariffs.

Rates for Electricity Supply. Etienne de Fodor. A discussion of the conditions which led to the present rates, reviewing the history of electrical current tariff, and considering the advantages to be derived from a unit price. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65305 D.

The Tariff Question in Electric Stations (Zur Tariffrage der Elektricitätswerke). Fritz Hoppe. Discussing the best methods of charging for electric current supply, considering the side both of the producer and the consumer. 7000 w. Elektrotech Zeitschr—Aug. 25, 1904. No. 65156 B.

Transformers.

Transformer Testing for Central Stations. S. E. Johanneson. Read before the Ohio Elec. Lgt. Assn. Describes the methods of making the various tests which may be applied to transformers. 4700 w. Elec Rev, N Y—Sept. 17, 1904. Serial. 1st part. No. 65013.

Turbo-Generators.

A Turbo-Electric Plant in a Paint Works. Illustrated description of a Cleveland plant for a large paint and varnish manufactory. 2500 w. Engr, U S A—Sept. 1, 1904. No. 64822 C.

Effect of the Steam Turbine on Central Station Practice. W. L. R. Emmet. A discussion of the advantages claimed for the steam turbine, the conditions that lead to their adoption, and the points of greatest importance. 3800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65299 D.

Steam Turbine Generators. B. A. Behrend. Discusses the mechanical requirements and principles of their design. Ills. 2000 w. Elec Rev, N Y—Sept. 10, 1, 1904. No. 64822 C.

Turbo-Generators Exhibited at the World's Fair. Illustrates and describes the exhibits of the Westinghouse, General Electric, and De Laval companies. 3000 w. Elec Rev, N Y—Sept. 10, 1904. No. 64944.

LIGHTING.

Arc Lamps.

Points for Consideration When Purchasing Alternating-Current Arc Lamps. G. Brewer Griffin. Abstract of a paper read before the Ohio Elec Lgt Assn. Discusses the construction and performance, the effect upon the eye, etc. 4000 w. Elec Rev, N Y—Sept. 3, 1904. No. 64827.

Raising and Lowering Gear for Arc Lamps. Donald Smeaton Munro. States the points of a good gear, and describes an appliance which seems to meet the requirements. Ills. 1700 w. Elec Rev, Lond—Sept. 16, 1904. No. 65243A.

Arcs.

The Electric Arc. Prof. C. D. Child. An attempt to make plain the principles on which an explanation of the electric arc must be based, to consider the different views which are possible, show what facts can be explained and what questions must yet be answered. 2800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65341 D.

Automatic Lighting.

An Automatic Lamp Lighting and Extinguishing Device. Dr. Alfred Gradenwitz. Illustrates and describes a device for automatically lighting and extinguishing lamps of any kind. Invention of Mr. E. Ruhmer. 800 w. Sci Am Sup—Sept. 24, 1904. No. 65085.

Filaments.

Treating Incandescent Lamp Filaments. Ralph McNeill. An outline of the "treating" or "flashing" of the filament. Ills. 1500 w. Elec Wld & Engr—Sept. 3, 1904. No. 64830.

MEASUREMENT.

Curves.

Causes for the Deformation of the Pressure Curves in Alternators (Die Ursachen der Deformationen von Spannungskurven in Wechselstrommaschinen). P. Wangemann. A study of the deviation of the pressure curves from the theoretical sine form, showing the influence of the arrangement of poles, and of the construction of the machine. Two articles. 7500 w. Elektrotech Zeitschr—Sept. 8, 15, 1904. No. 65161 each B.

Dynamo Losses.

The Division of Losses in Continuous-Current Dynamos (Beitrag zur Trennung der Effecktverluste in Gleichstrommaschinen). E. Cramer. Deriving equations and curves for the separation of the hysteresis and eddy-current losses. 1200 w. Elektrotech Zeitschr—Aug. 8, 1904. No. 65154 B.

Dynamometer.

The Electrodynamometer (Ueber Elektrodynamometer). Dr. Th. Bruger. Describing a convenient instrument for the direct indication of the energy developed by an alternating current. 3000 w. Elektrotech Zeitschr—Sept. 15, 1904. No. 65167 B.

Laboratory.

The Equipment of a Commercial Testing Laboratory. Dr. Clayton H. Sharp. An outline of the equipment needed for the various kinds of work to be done, and the conditions that must be kept in view. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65274 D.

Meters.

American Meter Practice. George Ross Green. Information concerning meter practice in America, compiled from letters received from a large number of electric lighting companies. Ills. 14400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65302 D.

A Standard for Quick Meter Calibration. George T. Hanchett. Suggests a method which, although rather expensive in first cost is justified when there are many rotary standards to be calibrated daily. 1000 w. Cent Sta—Sept., 1904. No. 64923.

A Study of Integrating Electric Meters. Caryl Davis Haskins. A record of such starting points as have up to the present time been shown to be worthy of development into an integrating meter. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65306 D.

Photometry.

On Large Bulb Incandescent Lamps as Secondary Standards of Light. J. A. Fleming. Abstract of a paper read before the British Assn. Gives points of importance in the construction of these lamps, and precautions to be taken in their use with information of interest. 2000 w. Elect'n, Lond—Aug. 26, 1904. No. 64858 A.

Photometric Experiments with Selenium. FitzHugh Townsend. Describes the use of selenium as a means for measuring light. Also editorial. 3300 w. Elec Rev, N Y—Sept. 10, 1904. No. 64945.

Standards of Light. Prof. Edward L. Nichols. Discussion of various standards, principally the amyl-acetate flame and the acetylene flame, with tables and curves. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65334 D.

Reichsanstalt.

The Work of the Physical-Technical Reichsanstalt for 1903 (Die Tätigkeit der Physikalisch-Technisch Reichsanstalt im Jahre 1903). An abstract of that portion of the report for 1903 relating to the testing and calibrating of electrical apparatus and other electrical work. 4500 w. Elektrotech Zeitschr—Sept. 8, 1904. No. 56164 B.

Standards.

Experiments for Improving the Construction of Practical Standards for Electrical Measurements. Abstract of the report of a committee of the British Assn. 2500 w. Elect'n, Lond—Sept. 9, 1904. No. 65031A.

Testing.

The Testing of Alternating Current Generators. B. A. Behrend. Describes an improved method devised by the author for testing alternating-current generators and synchronous motors, under full-load conditions, without actually having to place the machines under full load. Ills. 1300 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65297 D.

Units.

The So-called International Electrical Units. Dr. Frank A. Wolff. Historical review and discussion of units and standard cells. 9500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65332 D.

Voltameters.

The Lead Voltameter. Anson G. Betts and Dr. Edward F. Kern. Gives a short account of the silver voltameter, and the results obtained by comparing the lead voltameter. 2500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65325 D.

The Silver Voltameter. Dr. K. E. Guthe. Gives rules adopted in the United States where the silver voltameter has been legalized, and discusses sources of trouble that may arise, etc. 3500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65326 D.

MOTORS.

Alternating Current.

Alternating-Current Motors. Charles Proteus Steinmetz. Gives a general theory of the alternating-current motor, applicable alike to the induction and commutator motors to enable a critical judgment of their advantages and disadvantages. 11000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65270 D.

Diagrams.

The Circle Diagram for Speeds Above Synchronism (Das Kreisdiagram für Ueber Synchronismus). Dr. Gustav Benischke. A review of the contention of Müller as to the inapplicability of the circle diagram to induction motors at speeds above synchronism, showing that by a modified construction the diagram may be successfully applied. 1800 w. Elektrotech Zeitschr—Aug. 25, 1904. No. 65157 B.

Induction Motors.

A Method of Designing Induction Motors. H. M. Hobart. An investigation limited to three-phase squirrel-cage induction motors. 1600 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65318 D.

The Hopkinson Test as Applied to Induction Motors. W. E. Sumpner and R. W. Weekes. Gives experimental details of a test made of a number of induction motors, by this method. 2000 w. Elec Engr, Lond—Aug. 26, 1904. No. 64865 A.

The Reluctance of the Air-Gap in the Induction Motor. N. Pensabene. Considers the case of semi-enclosed slots in stator and closed slots in rotor, and also the case where both stator and rotor have semi-enclosed slots. 700 w. Elec Engr, Lond—Aug. 26, 1904. No. 64864 A.

Parallel Operation.

Some Practical Experiences in the Operation of Many Power Plants in Parallel. R. F. Hayward. A review of the lessons learned from the long-distance transmission plants operating in parallel, and supplying power over large areas of territory. 6300 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65311 D.

Repulsion Motors.

The Repulsion Motor. A. S. M'Allister. An explanation of its inherent characteristics, calculation of performance, etc. 2500 w. Am Elect'n—Sept., 1904. No. 64844.

Single Phase.

Improved Commutator-Motors for Single-Phase Alternating Currents (Neue Kollektormotoren für Einphasigen Wechselstrom). Clarence Feldmann. An examination of the action of the commutator as used on single-phase alternating motors. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 20, Sept. 10, 1904. No. 65106 each D.

Single-Phase Motors. Max Deri. A review of the essential functions and relations of modern single-phase motors in order to facilitate a comparison of the working conditions and commutating requirements of the different systems. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65300 D.

TRANSMISSION.

Cables.

Insulating Materials in High-Tension Cables. E. Jona. Discusses the various materials used, their enduring qualities, tests made, etc. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65303 D.

The Insulation of Cables (Ueber Kabelisolation.) J. Schmidt. Discussing the materials employed for the insulation of cables carrying high voltage currents. 2000 w. Zeitschr f Elektrotechnik—Sept. 11, 1904. No. 65172 D.

Conductors.

Conductors for Long Spans. Francis O. Blackwell. Gives results of investigations made to determine the characteristics of conductors so as to secure some definite basis upon which to figure long spans. 2800 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65314 D.

France.

Electric Transmission in France. Daniel Bellet. Illustrates and describes an installation designed to distribute power and light throughout the Aude, in the Pyrenean district, by high tension mains branched off from a central distributing station located 43.5 miles from the power house. 2800 w. Trac & Trans—Sept., 1904. No. 64960 E.

High Tension.

American Practice in High-Tension Line Construction and Operation. Dr. F. A. C. Perrine. A review of what is considered the best practice. 5500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65316 D.

Report of Committee on High-Tension Transmission. Presents in a condensed form, answers to a set of questions sent out. Also discussion on the report. Ills. 19000 w. Trans Am Inst of Elec Engrs—Sept., 1904. No. 65099 D.

Report on High Voltage Transmission Lines. Report to the Utica convention of the committee appointed to investigate the dangers incident to high voltage power transmission lines. 1800 w. St Ry Jour—Sept. 24, 1904. No. 65217 C.

Some Difficulties in High-Tension Transmission and Methods Mitigating Them. J. F. Kelly and A. C. Bunker. Discussing the conditions which affect and limit the constants and operation of high-tension lines, considering only pressures of over 30,000 volts and lines of over 50 miles in length. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65309 D.

The Construction and Insulation of High-Tension Transmission Lines. M. H. Gerry, Jr. Discusses the problems connected with this work. The methods are drawn entirely from American practice. Ill. 4500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65317 D.

The Twickenham and Teddington Electricity Undertaking. Max J. E. Tilney. An illustrated outline of a high-tension scheme now in progress. 2300 w. Elect'n, Lond—Sept. 16, 1904. No. 65245 A.

Insulation.

Some Elements in the Design of High-Pressure Insulation. Prof. Harris J. Ryan. Presents the elements of modern electrical science upon which must rest the trained judgment of the designer of high-pressure insulation, with tests and measurements. 4500 w. Int Elec Cong of St Louis—Sept., 1904. No. 65272 D.

Long Distance.

High Potential, Long Distance Transmission and Control. F. G. Baum. Gives the practice and results on the greatest transmission system in existence—the California Gas and Electric Corporation. 5000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65313 D.

The Bay Counties Power Co.'s Transmission System. L. M. Hancock. Gives an outline of the general and controlling features, dealing more at length with the organization of the forces to operate the plant and to carry on construction and repairs of a long distance plant in California. 5500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65312 D.

Power Development.

Rock Creek, Oregon, Power and Transmission System. An illustrated description of an interesting power development in a thinly populated district of the West. 2000 w. Elec Wld & Engr—Sept. 3, 1904. No. 64829.

MISCELLANY.

Contractors.

The Status of the Electric Contractor. A. H. Scott. Reviews the history of the organization and growth of the National Electrical Contractors' Association of the United States. 2500 w. Elec Wld & Engr—Sept. 10, 1904. No. 64948.

Exposition.

Some of the Electrical Features of the Exposition. E. B. Ellicott. Calls attention to some points of interest in the electrical work. Ills. 2500 w. Jour W Soc of Engrs—Aug., 1904. No. 65096 D.

Inspection.

The Growing Duties and Responsibilities of the Municipal Electrician. Capt. William Brophy. An account of the work performed formerly by insurance inspectors, and now being assumed by municipal authorities, discussing its evils. 2000 w. Elec Wld & Engr—Sept. 10, 1904. No. 64949.

The Inspection and Insurance of Electrical Machinery. From the report of Mr. Michael Longridge, giving interesting records of the experience of his company in connection with the working and breakdown of electrical machinery. 6500 w. Mech Engr—Sept. 10, 1904. No. 65026 A.

INDUSTRIAL ECONOMY

Accounts.

Foundry Casting Accounts. J. Davidson. Gives forms used, with explanatory remarks. 700 w. Foundry—Sept., 1904. No. 65072.

Apprentices.

The Foundry Apprentice as Seen in One Shop. Charles H. Thomas. Read before the A. F. A. Convention. Discusses the question of apprenticeship in the foundry, and suggests ways of interesting and helping the boys. 1200 w. Foundry—Sept., 1904. No. 65068.

Cost Keeping.

Gathering Engineering Cost Data. Halbert P. Gillette. Abstracted from a lecture before the civil and mining engineering students of Columbia University.

Suggestions on the methods of securing and using cost data. 4000 w. Sch of Mines Qr—July, 1904. No. 65058 D.

Education.

The Education of a Technical Chemist. Sir William Ramsay. Address before the Society of Chemical Industry. Suggestions of value. 5000 w. Sci Am Sup—Sept. 17, 1904. No. 64987.

The Outlook for Engineering Education. C. Frank Allen. Extracts from the presidential address before the Society for the Promotion of Engineering Education. Discusses the fields open to men trained as engineers, and the preparation best suited to meet the requirements. 3500 w. Eng News—Sept. 15, 1904. No. 64981.

Exposition.

The International Exposition at St. Louis (Die Weltausstellung in St. Louis). Fr. Frölich. An excellent and fully illustrated description of the technical and engineering features of the exposition by the special representative of the Verein Deutscher Ingenieure. Three articles. 18000 w. Zeitschr d Ver Deutscher Ing—Aug, 27, Sept. 3, 10, 1904. No. 65107 each D.

The St. Louis Exposition from the Standpoint of the Engineer. W. H. Bryan. A handsomely illustrated account of the exposition, treating of the salient points of the project, its execution, and the exhibits of mechanical interest. 5000 w. Engineering Magazine—October, 1904. No 65191B.

Iron Industry.

The Census of the Iron Ore Industry. A review of the special report for the Twelfth Census, prepared by John Birkinbine, showing the phenomenal growth 6400 w. Ir Age—Sept. 15, 1904. No. 64971.

Labor.

The Labor Problem. F. J. Symmes. Read before the Pacific Coast Gas Assn. A discussion of the labor unions and their attitude and what has been accomplished in overcoming difficulties. General discussion. 6000 w. Pro Age—Sept. 15, 1904. No. 64978.

Patents.

Compulsory Working of Patented Inventions—A British View. W. Craig Henderson. Discusses the question whether patentees ought to be compelled, on penalty of forfeiture, to work their inventions in the country where a patent has been obtained. The view is adverse to compulsory working. 2800 w. Elec Wld & Engr—Sept. 3, 1904. No. 64831.

Piece Work.

Piece Work. Le Grand Parish. With particular reference to the card department. 3000 w. Am Engr & R R Jour—Sept., 1904. No. 64788 C.

Premium System.

The Premium System in England and the United States (Le Système des Primes en Angleterre et aux Etats Unis). Jean Bosler. A review of the various modifications of the premium system for remunerating labor, showing their relation to modern intensified production. 4000 w. Revue de Mécanique—Aug. 31, 1904. No. 65135 E + F.

Shop Records.

A Work in Progress Record. H. B. McCabe. Describes a shop system for use where large quantities of the same article are made. 2200 w. Am Mach—Sept. 22, 1904. No. 65076.

State Control.

The Plan for the State Control of the Hibernia Coal Mines (Die Geplante Verstaatlichung der Bergwerks-Gesellschaft Hibernia). H. Engel. An account of the plans of the Prussian Government to obtain a controlling influence in the coal syndicate. 3000 w. Glückauf—Aug. 13, 1904. No. 65142 D.

Subsidies.

French Shipping Subsidies. A review of the laws dealing with navigation subsidies in France, discussing the results. 2500 w. Trac & Trans—Sept., 1904. No. 64967 E.

Subsidies with Relation to American Shipping. Briefly reviews the steps taken by other countries to increase the mercantile marine, and the effect. Also considers the best means for America to adopt. 2500 w. Marine Engng—Sept., 1904. No. 64782 C.

Technology.

The Influence of the Technical Department Upon the Workshop (Der Einfluss des Technischen Bureaus auf die Fabrikation). F. A. Neuhaus. A discussion of the great commercial value of a scientific technical department to the manufacturer. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1904. No. 65102 D.

Wages.

Discomfort vs. Skill as a Wage Basis. Thomas D. West. An argument against the position that a chief consideration in fixing wages should be the prosecution of the work under comfortable conditions. 2000 w. Ir Trd Rev—Sept. 8, 1904. No. 64875.

See also Mining & Metallurgy, Railway Engineering, and Street & Electric Railways.

MARINE AND NAVAL ENGINEERING

Battleship.

Machinery of the Italian Battleship Regina Margherita. Describes the machinery of an Italian warship which has just satisfactorily completed her official contract steam trials. Ills. 2000 w. Marine Rev—Sept. 15, 1904. No. 65008.

Boilers.

See Mechanical Engineering, Steam Engineering.

Ferryboats.

American Ferryboats. Illustrations and brief review of main types in use, with list of the screw and paddle ferryboats of the United States. 2500 w. Naut Gaz—Sept. 1, 1904. No. 64823.

The New Staten Island Ferryboats. An illustrated description of these boats which will be the finest vessels of their class in the world. 4000 w. Naut Gaz—Sept. 1, 1904. No. 64824.

The New Ferryboats for the New York-Staten Island Service. Illustrated description with specifications. 1500 w. Marine Engng—Sept., 1904. Serial. 1st part. No. 64781 C.

Fireboat.

Pacific Coast Fire-Boat. Illustrated description of a boat recently built for the city of Portland in Oregan. 900 w. Naut Gaz—Sept. 22, 1904. No. 65097.

Freight Steamer.

New Twin-Screw Freight Steamer Boston of the Fall River Line. Illustration, with brief description. 1200 w. Marine Engng—Sept., 1904. No. 64780 C.

Liquid Fuel.

A Comprehensive Extract from the Report of the "Hohenstein Boiler" and "Liquid Fuel" Boards. Gives such portions of the report as are of most general interest. Ills. 5000 w. Jour Am Soc of Nav Engrs—Aug., 1904. No. 65203 H.

Motor Boats.

Problem of the Auto Boat. William F. Durand. Discusses elements of successful hull design in the present number. 1800 w. Automibile—Sept. 3, 1904. Serial. 1st part. No. 64801.

Propeller-Blades.

Propeller-Blade Inaccuracies: Proposed Method of Machining and Finishing. W. Strother Smith. An official report to the Bureau of Steam Engineering. Describes a method of securing accurate finish of the driving face of a propeller-blade to the true designed pitch by means of a machine. 1200 w. Jour Am Soc of Nav Engrs—Aug., 1904. No. 65205 H.

Ship.

The Five-Masted Ship Preussen (Das Fünfmast - Vollschiff Preussen). W. Kaemmerer. Details of construction of full-rigged ship of five masts of 11,150 tons displacement. Steam steering and hoisting gear are used. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Aug. 20, 1904. No. 65105 D.

Shipments.

Mineral Shipments at British Ports. Brysson Cunningham. An illustrated review of the various systems in vogue for the shipment of minerals, such as coal and ore. 3000 w. Cassier's Mag—Aug., 1904. No. 65004 B.

Steamers.

The Austrian Lloyd's Steamer "Africa." Illustrated description of a recently built twin-screw steamer for the East African line. 1000 w. Engng—Sept. 2, 1904. Serial. 1st part. No. 64960 A.

The "Minnesota," the Largest Steamship Ever Built in America. Illustrated description of a large vessel built for the Pacific trade. 1000 w. Sci Am—Sept. 3, 1904. No. 64759.

Submarines.

Submarine Navigation (La Navigation Sous-Marine). H. Noalhat. A review of the problems which are involved in the attainment of successful submarine navigation. Serial. Part I. 3000 w. Revue Technique—Aug. 10, 1904. No. 65126 D.

Troopship.

The Indian Troopship "Dufferin." Gives information of the progress made in this class of vessels, describing the "Dufferin," recently launched. 1500 w. Engng—Sept. 16, 1904. No. 65248 A.

Tugs.

Italian Sea-going Salvage Tug Sars. Illustrations, with brief description. 700 w. Marine Engng—Sept., 1904. No. 64783 C.

Turbine Steamers.

The New Cunard Turbine Steamers. Illustrates and describes the exhibits of the Cunard Steamship Company at St. Louis, giving information of the most notable features of the turbine steamers. 1000 w. Sci Am—Sept. 10, 1904. No. 64919.

United States Navy.

The Naval Strength of the United

States. George W. Melville. Considers some of the factors that have been given too little consideration in the past in estimating the relative strength of navies, and related matters of interest. 8400 w. Jour Fr Inst—Sept., 1904. No. 65064 D.

Unloading.

New Grain Elevators at Leith Docks. Describes elevators in Scotland for the rapid discharging of grain ships. 1300 w. Engr, Lond—Sept. 9, 1904. No. 65043 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Belt Transmission.

Flexible Power Transmission for Motor Vehicles. Sidney Russell. An illustrated review of belt-driven motor vehicles is given in this article. 6000 w. Trac & Trans—Sept., 1904. No. 64968 E.

Diagram.

Power Diagram for Motor Vehicles. P. S. Bushnell. Gives diagram for solving problems in motor vehicle design, involving the relation of the speed of the vehicle to the traction, the percentage of gradient and power required under various conditions. 400 w. Am Mach—Vol. 27, No. 36. No. 64888.

Ignition.

High Tension Magneto-Ignition. Illustrated descriptions of the construction of the best known forms of this apparatus, the Eisemann, the Simms-Bosch and the Bassie-Michel. Also discusses the ignition question in general. 1300 w. Auto Jour—Sept. 3, 1904. Serial. 1st part. No. 64955 A.

Omnibus.

A Forty-Passenger Automobile. Illustrated detailed description of a sightseeing automobile with terraced seats. 1200 w. Ir Age—Sept. 22, 1904. No. 65074.

The Clarkson Steam Motor Omnibus. Illustrated detailed description of an English vehicle. 1300 w. Engng—Sept. 16, 1904. No. 65249 A.

Petrol Cars.

The "Dixi" Petrol Cars. Illustrates and describes these cars, particularly those having a tubular chassis construction. 1000 w. Auto Jour—Sept. 17, 1904. Serial. 1st part. No. 65237 A.

The 1904 Panhard-Levassor Petrol Cars. An illustrated detailed description of the 1904 models, particularly the 4-cylinder 10-h. p. and the 3-cylinder 8-h. p. types. 2200 w. Auto Jour—Aug. 27, 1904. Serial. 1st part. No. 64854 A.

Rover.

The New 8-H. P. Rover Car. Illustrates and describes this car, which is one of the new machines entered in the small car trials. Its striking features are the central box girder in place of the usual frame, the engine brake and disc clutch. 1800 w. Autocar—Aug. 27, 1904. No. 64853 A.

Side-Slip.

Side-Slip in Motor Cars. Horace Darwin and C. V. Barton. An explanation of one of the causes of skidding of wheels on motor cars when on slippery roads. 3000 w. Autocar—Sept. 10, 1904. No. 65024 A.

Touring Car.

Welch Gasoline Touring Car. Illustrates and describes this year's design, noting the improved features. 800 w. Automobile—Sept. 10, 1904. No. 64933.

Trials.

Small Car Reliability Trials at Hereford. An illustrated account of trials of cars costing £200 or less. Also details of the cars entered. 7700 w. Autocar—Sept. 3, 1904. Serial. 1st part. No. 64954 A.

HEATING AND COOLING.

Air Flow.

The Measurement of Air Flow (Ueber die Messung von Luftschwindigkeiten). Dr. A. Marx. An exhaustive study of the measurement of the velocity of the flow of air in ventilating passages and conduits, discussing anemometers, pressure gauges and other instruments. Serial. Part I. 4500 w. Gesundheits Ingenieur—Aug. 20, 1904. No. 65181 B.

Central Plant.

The Central Heating and Ventilating Plant of the Leipzig City Hall (Die Zentral heizungs und Lüftungsanlage im Rathausneubau zu Leipzig). Ludwig Dietz. With plans of the building showing arrangement of the direct and indirect heating, steam plant, etc. 5000 w. 4 plates. Gesundheits-Ingenieur—Sept. 10, 1904. No. 65182 B.

Exhaust Steam.

Performance of a Plant with Heating from the Exhaust of Condensing Steam Turbines. Illustrates and describes a very interesting plant installed in the Wing Building, New York City. This is a seven-story structure devoted to manufacturing. 2800 w. Eng Rec—Sept. 3, 1904. No. 64812.

Fans.

Centrifugal Fans and Their Application to the Heating of Industrial Buildings. R. B. Hayward. A study of the application to the heating and ventilating of industrial buildings. General discussion. 11000 w. Pro Engrs' Soc of W. Penn—June, 1904. No. 65051 D.

Refrigeration.

Refrigerating Plants at Louisiana Purchase Exposition. An illustrated detailed description of this very interesting exhibit. 8500 w. Ice & Refrig—Sept., 1904. No. 64808 C.

HYDRAULICS.

Flow.

A Diagram for the Flow of Water in Pipes. Ernest W. Schoder. Gives diagram and explanation of its use in solving problems in pipe hydraulics. 1300 w. Eng Rec—Sept. 3, 1904. No. 64813.

Diagram Giving Discharge of Pipes by Kutter's Formula. John H. Gregory. Claims to be the originator of the diagram published by Prof. I. P. Church and calls attention to other diagrams which have been published, which are plotted in a similar manner. 1600 w. Eng Rec—Sept. 17, 1904. No. 65020.

See also Civil Engineering, Waterways.

Pumping.

A Molasses Pumping Plant in Boston. An account of the plant designed for discharging molasses from tank steamers into tanks in the storehouses. Ills. 3000 w. Eng Rec—Sept. 17, 1904. No. 65016.

The Application of Electric Power to the Drainage of Marshes in the Netherlands (Entwässerung von Marschländereien durch Elektrische Kraftübertragung in den Niederlanden). A description of the use of electric motors and centrifugal pumps for draining polders in the vicinity of Geertruidenberg. 2500 w. Glasers Annalen—Sept. 15, 1904. No. 65149 D.

The Latest Development of Pumping Systems (Die Neueste Entwicklung der Wasserhaltung Sowie Versuche mit Verschiedenen Pumpensystemen). H. Baum. An exhaustive review of the present status of mine pumping, with illustrations of the various machines and systems. Serial. Part I. 3000 w. Glückauf—Aug. 20, 1904. No. 65143 D.

See Mining and Metallurgy, Mining.

Regulator.

Automatic Regulator for Pumps (Pompe à Régulateurs Automatiques de Debit). A description of the Daubron system. especially adapted for maintaining a supply to filters under constant pressure. 600 w. Génie Civil—Sept. 10, 1904. No. 65122 D.

Siphons.

Siphons: Their Action and Uses in Plumbers' Work. J. Wright Clarke. An illustrated explanation of siphon action and its limit in plumbing work. 2500 w. Plumb & Dec—Sept. 1, 1904. Serial. 1st part. No. 64950 A.

Water Motor.

A Home-Made Water Motor of One-Quarter Horse Power. H. F. Swartz. Illustrates and describes an impulse wheel which developed 0.28 brake h. p. and 1000 revolutions on a pressure of 50 pounds. 800 w. Sci Am Sup—Aug. 20, 1904. No. 64742.

Water-Power.

Developing a Water-Power. Thorburn Reid. Discusses the elements of financial and commercial success in such undertakings. 3800 w. Cassier's Mag—Aug., 1904. No. 65006 B.

INTERNAL-COMBUSTION MOTORS.

Alcohol.

International Exposition of Alcohol (L'Exposition Internationale des Alcools). G. Coupan. An illustrated account of the exposition recently held at Vienna, including the trials of automobiles using alcohol as fuel. 3000 w. Génie Civil—Aug. 27, 1904. No. 65117 D.

Carburetters.

Carburetters for Alcohol Motors (Carburateurs pour Moteurs à Alcool). Réné Dhommée. Discussing the conditions involved in the production of a suitable vaporized charge from alcohol and air, with illustrations of a number of special carburetters for use with alcohol motors. 1200 w. Revue Technique—Aug. 10, 1904. No. 65127 D.

Diesel.

Trial of a 240-H. P. Diesel Oil Engine. Michael Longridge. An account of the trials made at the maker's works in Ghent, showing 42 per cent. efficiency. 2500 w. Mech Engr—Sept. 17, 1904. No. 65239 A.

Efficiency.

The Economics of Power Engines. Bernhard A. Sinn. Deals principally with explosive engines, but also considers steam engine efficiency and describes the marine gas suction generator. 2500 w. Marine Engng—Sept., 1904. No. 64784 C.

Exhaust Gases.

The Calorimetry of the Gases Exhausted from an Internal Combustion Engine. B. Hopkinson. Abstract of a paper before the British Assn. Describes tests in which the exhaust gases were passed through a calorimeter and so cooled to near atmospheric temperature, the heat rejected by then being measured. Ills. 2500 w. Engng—Aug. 26, 1904. No. 64869 A.

Flame Temperatures.

Flame Temperatures in Internal Combustion Motors. Dugald Clerk. Read before the British Assn. A study of the possibility of reducing flame temperatures by artificial enhanced atmospheric pressures. 1800 w. Elect'n, Lond—Aug. 26, 1904. Serial. 1st part. No. 64861 A.

Gas Producers.

Gas Producers for Power. Julius I. Wile. An illustrated article dealing with the several types of producers and their applications and advantages. 4000 w. Power—Sept., 1904. No. 64748 C.

Suction Gas Producer for Use with Explosive Motors Employing Low-Grade Gas Produced Direct from Coal. Illustrates and describes a gas generating installation of the Pierson system. 1500 w. Sci Am Sup—Sept. 3, 1904. No. 64762.

Gas Turbine.

The Efficiency of the Gas Turbine (La Turbine à Gaz—Son Rendement). Alfred Barbezat. Describing the Armengaud and Lemâle gas turbine, with computations of efficiency for various ranges of temperature. 2500 w. Schweiz Bauzeitung—Aug. 27, 1904. No. 65177 B.

Inertia.

Inertia in Gas and Steam Engines. A. T. Kasley. Explains the meaning of inertia and considers some problems. General discussion. 3000 w. Pro Engrs' Soc of W. Penn—July, 1904. No. 65053 D.

Testing.

Tests of an Oil Engine with Steam Injection. Gives an abstract of the results obtained by Messrs. Charles Wineburgh and S. J. Goldwater in testing for oil consumption, a 15-h. p. engine of unusual type placed on the market by Mietz & Weiss, of New York. 4200 w. Eng News—Sept. 15, 1904. No. 64982.

MACHINE WORKS AND FOUNDRIES.

Automatic Machines.

Automatic Screw Machines and Attachments. Engravings, with descriptive notes. 2200 w. Am Mach—Vol. 27. No. 36. No. 64889.

The New Hartford Automatic Screw and Forming Machines. Illustrated description of the machine and its operation. 2200 w. Ir Age—Sept. 8, 1904. No. 64876.

Castings.

Molding and Casting of a Gas Engine Cylinder, with Special Treatment of the Casting After Pouring. R. H. Palmer. Illustrated description of the methods used. 1800 w. Am Mach—Vol. 27. No. 37. No. 64973.

Molding a Slag Vessel. Robert Jones. Illustrates and describes method employed. 600 w. Am Mach—Vol. 27. No. 38. No. 65075.

Molding in Cores. H. J. McCaslin. Illustrates and describes methods of making a variety of castings. 1700 w. Foundry—Sept., 1904. No. 65069.

Warping of Castings. Thomas Mack. Illustrates and describes a warped casting and the means adopted for remedying the trouble, discussing the cause. 1000 w. Foundry—Sept., 1904. No. 65066.

Charts.

Charts in Designing. John S. Myers. Explains the applicability of record charts and of calculating charts. 2800 w. Mach, N. Y.—Sept., 1904. No. 64770 C.

Cores.

Mechanically Made Cores. George H. Wadsworth. Read before the Found. Assn. Describes the three methods of producing cores by mechanical means, illustrating Wadworth's core-making machine. 2000 w. Ir Trd Rev—Sept. 15, 1904. No. 64991.

Cupolas.

Blowing Small Cupolas from Stand Pipes. Walter J. May. Directions, with illustrations. 1100 w. Prac Engr—Aug. 26, 1904. No. 64855 A.

Dust Chamber.

Dust Chamber Design. Max J. Welch. Illustrations, with descriptions of types of dust chamber construction for collecting flue dust and condensing fumes. 1200 w. Eng & Min Jour—Sept. 1, 1904. No. 64768.

Electric Driving.

Electric Motors in Machine Shop Service. Charles Day. The subject is considered from the standpoint of the shop engineer, whose one thought is economy. 6000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65275 D.

Elswick Works.

The Armstrong Works at Elswick. E. Guarini. Views, with some points in the history of the development of these works. 1200 w. Am Mach—Vol. 27. No. 35. No. 64757.

Engine Repairs.

An Emergency Engine Repair. Lewis F. Lyne. Illustrated description of repairs made to an engine of the center crank type, which had been wrecked by the breaking of a rod strap on the cross-head and of the connecting rod. 1100 w. Power—Sept., 1904. No. 64751 C.

Exhausters.

Exhausting Appliances for the Removal of Chips and Dust (Exhaustoranlagen, Insbesondere zur Beseitigung von Spänen und Staub). Hr. Geiger. A discussion of the arrangement of exhaust conveyors in wood-working establishments, with computations of the power required. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1904. No. 65113 D.

Forging.

Economy and Advantage of Oil Fuel for Forging. S. Uren. Read before the Nat. R. R. Master Blacksmiths' Assn. Claims that oil at 6 cents per gallon and coal at $5 per ton about balance as far as cost is concerned, but that the improvement in the quality of the iron is incalculable. 1200 w. Am Mach—Vol. 27. No. 37. No. 64974.

Forging Press.

The Development of the Hydraulic Forging Press (Gesichtspunkte für die Einrichtung von Schmiedepressen-Anlagen). O. Peter. A review of the application of hydraulic pressure to forging and forming operations, with numerous illustrations. Two articles, 6000 w. Glasers Annalen—Aug. 15, Sept. 1, 1904. No. 65145 each D.

Foundry.

Foundry of Stilwell-Bierce & Smith-Vaile Co., Dayton, Ohio. Illustrated detailed description of a foundry manufacturing principally pumps and water wheels. 1500 w. Foundry—Sept., 1904. No. 65065.

Gear Box.

A Milling Machine Gear Box Feed with 25 Changes. A. H. Schkommodan. Illustrated description. 600 w. Am Mach—Vol. 27, No. 38. No. 65077.

Lathes.

A Large Bardons & Oliver Lathe. Illustrated description of a heavy turret lathe for operating on bar stock up to six inches in diameter. 2500 w. Mach, N. Y.—Sept., 1904. No. 64771 C.

Machine Tools.

Specialized Machine Tools. Joseph Horner. An explanation of the present understanding of *special tools,* with illustrations of various machines and discussion of their development, value, etc. 4500 w. Cassier's Mag—Aug., 1904. No. 65005 B.

Melting.

Economy in Melting. J. P. Pero. A brief consideration of present practice, with suggestions for securing economy. 1500 w. Foundry—Sept., 1904. No. 65073.

Milling.

Planing and Milling (Hobeln und Fräsen). Dr. G. Schlesinger. A comparison of the relative advantages of planing and milling as machining processes, showing the economical advantages of the latter method of metal working. 3500 w. Zeitschr d Ver Deutscher Ing—Sept. 10, 1904. No. 65112 D.

Milling Cutters.

High-Spead Steel for Milling Cutters. Gives in detail results obtained with milling cutters of high-speed steel, with half-tone illustrations. 1200 w. Am Mach—Vol. 27. No. 35. No. 64756.

Planing.

Cutting Test on Metal Planer. J. C. Steen. Describes a cutting test made during the regular progress of the work through the shop, on a casting weighing 3,000 lbs. 700 w. Am Engr & R R Jour—Sept., 1904. No. 64792 C.

Pneumatic Tools.

Operative Costs of Pneumatic Tools (Betriebs Kosten der Pressluftwerkzeuge). H. Cordes. Data of the cost of using pneumatic hammers, riveters, drills and other tools in Germany. 2000 w. Glasers Annalen—Aug. 15, 1904. No. 65146 D.

Sand.

Molding Sand. F. J. H. Merrill. Where it is obtained, its quality, etc. 900 w. Eng & Min Jour—Sept. 1, 1904. No. 64764.

Shops.

Imperial Works of the Oil Well Supply Co., Oil City, Pa. Gives a map of the property and an illustrated description of these extensive works and their equipment. 2400 w. Eng Rec—Sept. 24, 1904. No. 65227.

The New Building for the General Electric Machine Shop and Power House, Lynn. An illustrated detailed description of a steel-frame building, differing materially in its structural design from many large shops. 3500 w. Eng Rec—Sept. 17, 1904. Serial. 1st part. No. 65019.

The Plant of the International Harvester Company at Hamilton, Ontario. An illustrated description of large implement works showing many new features in design, equipment and construction. 4000 w. Ir Age—Sept. 1, 1904. No. 64785.

The Schneider Works in France, with Details of the Plants at Creusot and Havre. E. Guarini. Illustrated description with brief historical review. 3000 w. Ir Trd Rev—Sept. 1, 1904. No. 64773.

Specifications.

Specifications—And What They Mean to the Foundryman. David Reid. Read before the A. F. A. convention. Remarks on specifications in the foundry industry. 800 w. Foundry—Sept., 1904. No. 65071.

Stores.

Stores Arrangement as a Factor in Shop Management. John Ashford. The first article treats of the general plan of a system of keeping and handling stores in accordance with modern works management methods. 3000 w. Engng Mag—Oct., 1904. No. 65197 B.

Thread Cutting.

A Difficult Job of Square Thread Cutting. Herbert V. Purman. An illustrated detailed description of a very unusual piece of work. 2000 w. Am Mach —Vol. 27. No. 37. No. 64975.

Tools.

High-Speed Steel in Railroad Shops. Henry W. Jacobs. Discusses the main points to be considered in the introduction of the new alloy steel tools if beneficial results are expected. Ills. 2000 w. Am Engr & R R Jour—Sept., 1904. No. 64789 C.

The Introduction of High-Speed Steel Into a Factory. A. D. Wilt, Jr. Methods of determining the proper times, piece rates and costs due to the change from the old to the new tools. 2500 w. Engng Mag—Oct., 1904. No. 65193 B.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Change of Structure in the Solid State. W. Campbell. Gives a short account of the changes which occur during and after solidification in the alloys of copper and tin, iron and copper, steel and other alloys, with remarks on the importance of studying their effects. Ills. 5,000 w. Jour Fr Inst—Sept., 1904. No. 65062 D.

Some Neglected Details in the Experimental Study of Alloys. E. S. Shepherd. Points out several experimental details which have been neglected in some current researches, especially in pyrometric and metallographic work. Ills. 2500 w. Ir & Steel Mag—Sept., 1904. No. 65061 D.

Copper.

The Testing of Hard Drawn Copper. Lawrence Addicks. Notes the uses of hard drawn copper and the tests needed, describes the process of drawing and the method of testing. 3000 w. Elec Rev, N. Y.—Sept. 24, 1904. No. 65232.

Ferro Alloys.

See Electrical Engineering, Electro Chemistry.

Heat Effects.

The Influence of Heat Upon Mild Steel Plates (Versuche über die Festigkeitseigenschaften von Flusseisenblechen bei Gewöhnlicher und Höherer Temperatures). C. Bach. A very complete account of exhaustive experiments, with tables and diagrams. 2 articles, 7000 w. 4 plates. Zeitschr d Ver Deutscher Ing—Aug. 27, Sept. 3, 1904. No. 65109 each D.

Impact Tests.

Tensile Impact Tests of Metals. W. Kendrick Holt. Read before the Am. Soc. for Test. Mat. Illustrates and describes investigations made of the relative behavior of materials under impact and gradual loading and the results. 7000 w. Eng News—Sept. 8, 1904. No. 64911.

Iron.

Does Iron Expand? H. Sayers. Gives the reasons for the writer's conclusion that iron expands. 800 w. Foundry—Sept., 1904. No. 65070.

Lubricants.

Lubricating Oils and Their Properties: How to Test Them and to Direct Adulterations. W. M. Davis. 700 w. Power —Sept., 1904. No. 64749 C.

Metallography.

See Mining and Metallurgy, Iron and Steel.

Metal Protection.

Protection of Metallic Surfaces. N. Brandon. Read before the Inst. of Marine Engrs. An explanation of the action that takes place when rust is formed and the coverings used to protect metals, the conditions necessary, etc. 4000 w. Prac Engr—Sept. 9, 1904. No. 65025 A.

Nickel-Steels.

Allotropic Transformations of Nickel Steels. L. Dumas. Gives results of experiments at the steel works of Imply, France, in studying the influence of the allotropic condition on the properties of nickel steels. 5000 w. Ir & Steel Mag—Sept., 1904. No. 65060 D.

Stress.

Lecture on Recent Researches on the Effects of Stress Upon Metals. Dr. E. G. Cocker. An account of investigations which gave results of interest and importance. Ills. Also discussion. 3500 w. Pro Can Ry Club—April 5, 1904. No. 65049.

Steel.

Later Researches Upon Vanadium Steel (Nouvelles Recherches sur les Aciers au

Vanadium), Léon Guillet. Showing the behavior of vanadium steels under heat treatment and demonstrating that the only useful alloys are those containing less than 0.7 per cent. of vanadium. 1000 w. Comptes Rendus—Aug. 8, 1904. No. 65124 D.

A study of Molybdenum Steel (Recherches sur les Aciers au Molybdène), Léon Guillet. Data and results of a series of systematic tests, with microphotographs of various alloys. 2000 w. Génie Civil—Aug. 13, 1904. No. 65114 D.

Properties and Constitution of Chrome Steels (Propriétiés et Constitution des Aciers au Chrome). Léon Guillet. Giving results of a series of systematic tests, both mechanical and microscopic, showing the especial value of pearlitic chrome steels for tools. 1200 w. Comptes Rendus—Aug. 16, 1904. No. 65125 D.

Thermite.

Industrial Uses of Thermite. Notes, with illustrations, referring to rail welding, mending machinery, etc. 1400 w. U S Cons Repts—July, 1904. No. 64744 D.

Vibration.

The Fracture of Structural Steel Under Alternating Stresses. Prof. J. O. Arnold. A British Association paper discussing the weakening effects of vibration upon tough steel and describing methods of tests. 1200 w. Engr, Lond.—Sept. 2, 1904. No. 64964 A.

MEASUREMENT.

Calorimetry.

The Calorimetry of Gaseous Fuels. W. Garnet Wernham. Abstract of a paper read before the Junior Inst. of Engrs. Describes the method of finding the calorific value of a gas by analysis and by the direct calorimetric test, giving illustrated descriptions of various calorimeters. 4500 w. Mech Engr—Sept. 3, 1904. No. 64957 A.

Curves.

Curves of Performance. W. H. Booth. Some points in regard to the sizes and economies of engines. 1000 w. Power—Sept., 1904. No. 64747 C.

Dynamometer.

A Simple Dynamometer. W. J. Spiro. An illustrated detailed description of a dynamometer designed for use in testing a power transmission system in New York City. 3200 w. Sch of Mines Qr—July, 1904. No. 65056 D.

Instruments.

Some Micrometer Measuring Instruments. A. L. Monrad. Illustrated description of the writer's own design. 1800 w. Mach, N. Y.—Sept., 1904. No. 64772 C.

Pyrometry.

Methods of Pyrometry. C. W. Waidner. A brief treatment of the various pyrometric methods that are most widely used, with remarks on the importance of temperature control. Ills. 24600 w. Pro Engrs Soc of W. Penn—Sept., 1904. No. 65257 D.

Testing-Machine.

A Universal Testing Machine of 300 Tons for Full-Sized Structural Members. J. H. Wickstead. Read before the British Assn. at Cambridge. Illustrates and describes the machine, tracing the development and reporting its working. 2800 w. Engng—Sept. 2, 1904. No. 64961 A.

POWER AND TRANSMISSION.

Belts.

Splicing Leather Belts. W. E. Dixon. Describes the best and most convenient method of repairing and splicing belts of all ordinary kinds. Ills. 3200 w. Power—Sept., 1904. No. 64752 C.

Compressed Air.

Compressed Air in Hoisting. J. S. Lane. Illustrated descriptions of machinery used in applying compressed air to hoisting and similar work, discussing its advantages and giving general information. 4400 w. Compressed Air—Sept., 1904. No. 64972.

Electrically-Driven Underground Air-Compressors (Les Compresseurs d'Air à Commande Electrique pour les Installations Souterraines). H. Denis. Showing how the advantages of electric transmission and pneumatic appliances may be combined in mining operations. Serial. Part I. 2000 w. Revue Technique—Aug. 25, 1904. No. 65129 D.

Cranes.

A New German Tower Electric Crane. Frank C. Perkins. Brief illustrated description of an interesting electrically operated tower crane constructed at Karlsruhe. 700 w. Sci Am—Aug. 20, 1904. No. 64740.

Mechanical Plant.

Proportions of the Mechanical Equipment of the Whitehall Building, New York. Floor plan of the building with description of the equipment. 2000 w. Eng Rec—Sept. 17, 1904. No. 65018.

Power.

Power—Economical and Otherwise. F. S. N. Macrory. Describes a gas engine plant installed in an Irish oatmeal mill, discussing its advantages and disadvantages, etc. 2500 w. Elec Engr, Lond—Aug. 26, 1904. No. 64866 A.

Prime Movers.

The Prime Mover Situation. Dr. Louis Bell. Considers the reciprocating engine, the steam turbine, and the gas engine, discussing recent improvements. 2300 w. Elec Rev, N Y—Sept. 17, 1904. No. 65011.

Sanatorium Plant.

The Power Plant of the Agnes Memorial Sanatorium. Howard S. Knowlton. An illustrated study of a power plant for an institution designed and built with great care, for the treatment of pulmonary tuberculosis, near Denver, Colo. 3500 w. Eng Rec—Sept. 10, 1904. No. 64938.

Speed Variation.

Something New in Speed Changing Devices. A. L. de Leeuw. An illustrated description of the device and its operation. 2300 w. Am Mach—Vol. 27, No. 36. No. 64887.

Spiral Gearing.

The Solution of Problems in Spiral Gearing. E. C. Oliver. Explains a method, claimed to be simple and accurate, that will solve any problem. 1200 w. Am Mach—Vol. 27, No. 36. No. 64890.

STEAM ENGINEERING.

Boilers.

The Garbe Water-tube Boiler with Large Water Space (Der Garbesche Grosswasserraum Röhrenkessel). Fr. Geutsch. Describing a form of vertical water-tube boiler with large shells, with details of the forming of tube sheets, etc. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1904. No. 65103 D.

The Water-Tube Boilers of H. M. S. S. "Medusa," "Media," and "Hermes." Discusses some of the leading facts set forth in the last report of the Admiralty Committee on Naval Boilers. Deals with the Dürr, Babcock & Wilcox, and Yarrow boilers. Ills. 4000 w. Eng'ng—Aug. 26, 1904. Serial. 1st part. No. 64867 A.

Underground Boiler Plants at Pratt Coal Mines in Alabama. Erskine Ramsay. Describes the method of installation and some of the advantages realized from the arrangement. Ills. 1800 w. Mines & Min—Sept., 1904. No. 64880 C.

Boiler Rooms.

Boiler Room Management. Walter W. Edwards. Directions for preparing a battery of boilers for steaming. Ills. 3000 w. Am Elect'n—Sept., 1904. No. 64848.

Boiler Scale.

Boiler Scale and the Transmission of Heat. A. D. Risteen. Shows that many statements made in regard to the efficiency of boilers being seriously impaired by scale are not true, but that scale is objectionable because it raises the temperature of the boiler plate. 3500 w. Am Mfr & Ir Wld—Sept. 15, 1904. No. 65007.

Breakdowns.

Engine Breakdowns and Their Lessons. Michael Longridge. From the annual report of Michael Longridge, chief engineer of the British Engine, Boiler and Electrical Insurance Company, Ltd. Ills. 6000 w. Mech Engr—Aug. 27, 1904. No. 64857 A.

Chimneys.

Steel Chimneys and Their Construction. E. C. Sherman. Briefly explains the object of chimneys and how to compute the height and area, and gives particulars in regard to guyed and self-supporting steel chimneys. Ills. 1800 w. Engr, U S A—Sept. 1, 1904. No. 64821 C.

Clearance.

Clearance Reducing Valve Mechanism and Cylinder. Reviews the work in this field by J. B. Alfree and Ira C. Hubbell, giving illustrated description of their system. 2200 w. Ry Mas Mech—Sept., 1904. No. 64931.

Compound Engines.

The Effects of Receiver Drop in a Compound Engine. Joseph W. Hayward. Read before the British Assn. Deals with the results of four experiments, undertaken to demonstrate the effects of varying the point of cut-off in the low-pressure cylinder of a compound engine, other conditions being maintained constant. 700 w. Engr, Lond—Aug. 26, 1904. No. 64873 A.

Corrugated Furnaces.

The Relative Elasticity of the Fox and Morison Corrugated Boiler Furnaces (Versuche über die Verschiedenheit der Elastizität von Fox und Morison Wellrohren). C. Bach. Data and results of experimental tests, giving the longitudinal elasticity of both types under various stresses. 1500 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1904. No. 65104 D.

Costs.

Steam Costs in Industrial Combinations. William D. Ennis. A study of a systematic method of computing the cost of steam power from its various elements. 3000 w. Engineering Magazine—October, 1904. No. 65196 B.

Counterbalancing.

Balance Cylinders, Luther D. Lovekin. An illustrated article explaining the problem which confronts a true balance cylinder, and considering the forces to be overcome, and the applications made. 3500 w Jour Am Soc of Nav Engrs—Aug., 1904. No. 65204 H.

Engines.

New Design of Bates-Corliss Engine. An illustrated description of this new design, calling attention to the improvements. 1200 w. Engr, U S A—Sept. 15, 1904. No. 64976 C.

Tandem Compound Drop Valve Steam Engine. Illustrated description of a new type of engine. The special features are a positive valve-gear motion of a simple type, with very strong construction. 700 w. Engr, Lond—Sept. 2, 1904. No. 64962 A.

The 5,000-Horse-Power Engine at the World's Fair. C. J. Larson. Illustrated description of this powerful steam-electric unit and features involved in the installation. 3000 w. Eng Rec—Sept. 10, 1904. No. 64936.

Entropy.

Entropy in Steam Engine Practice. A study of the temperature-entropy diagram is given in the present number. 1700 w. Mech Engr—Aug. 27, 1904. Serial. 1st part. No. 64856 A.

Feed Water.

Feeding Steam Boilers. R. T. Strohm. Reviews the methods of supplying feed water, discussing their limitations. Ills. 2800 w. Am Elect'n—Sept., 1904. No. 64845.

Firing.

Progress in the Technology of Firing (Ueber Fortschritte in der Feuerungstechnik). Gustav Deutsch. A discussion of the firing of boiler furnaces, with special reference to underfeed stokers. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 2, 1904. No. 65151 D.

Liquid Fuel.

The Science of Burning Liquid Fuel. W. N. Best. Considers some of the advantages of this fuel over others, and how to obtain the best results. 1600 w. Sci Am Sup—Aug. 20, 1904. No. 64741.

See Marine and Naval Engineering.

Steam Heating.

See Mechanical Engineering, Heating and Cooling.

Superheating.

European Practice in the Use of Superheated Steam. Franz Koester. Reviews the history of its use and describes examples of modern engine equipment. 2200 w. Power—Sept., 1904. Serial. 1st part. No. 64755 C.

The Action of Superheated Steam in Reciprocating Engines (Fonctionnement de la Vapeur Surchauffeé dans les Machines à Pistons). F. Richter. A French translation by M. Lecuir, of Prof. Richter's important experimental researches at Charlottenburg. 10,000 w. Revue de Mécanique—Aug. 31, 1904. No. 63134 E + F.

The Pielock Superheater for Locomotives. Illustrated description of a superheater which is a strong competitor of the Schmidt in Germany. Also editorial. 1800 w. Ry Age—Sept. 9, 1904. No. 64899.

Superheated Steam for Locomotives in Germany. An account of what has been accomplished in this field. 4000 w. U S Cons Repts—July, 1904. No. 64745 D.

Turbines.

A Review of Steam Turbine Patents. Illustrates and describes types selected from the great number of patents, from 1827 to date. 3800 w. Mach, N Y—Sept., 1904. Serial. 1st part. No. 64769 C.

The Steam Turbine of the Allgemeine Elekticitäts Gesellschaft, Berlin. (Die Dampfturbinen der Allgemeinen Elektricitäts-Gesellschaft, Berlin). O. Lasche. A detailed account of the construction and manufacture of the steam turbine and turbine generating sets of the General Electric Company of Berlin. Two articles, 6000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 20, 1904. No. 65100 each D.

The Steam Turbine (Les Turbines à Vapeur). G. Hart. A general review of the development of the steam turbine, discussing the theory, and reviewing the various types. 30,000 w. 1 plate. Mem Soc Ing Civ de France—June, 1904. No. 65133 G.

The Zoelly Steam Turbine (Die Dampfturbine von Zoelly). Giving details of construction and regulation of the turbine built by Escher, Wyss & Co., of Zürich. 2500 w. Elektrotech Zeitschr—Sept. 8, 1904. No. 65163 B.

Warren-Crocker Steam Turbine. E. C. Crocker. Read before the Ohio Elec. Lgt. Assn. Describes the construction and governing and discusses the adaptation. 1500 w. Engr, U S A—Sept. 15, 1904. No. 64977 C.

Valves.

Valves and Valve Gears. Robert Gibson Griswold. An illustrated analysis of the various gears, with a careful study of the simple "D" slide valve and its effect upon the steam distribution and formation of the diagram. 2800 w. Power—Sept., 1904. Serial, 1st part. No. 64750C.

MISCELLANY.

Aeronautics.

The Contour Aeronaut (L'Aéronat F. Contour). H. de Graffigny. Describing a new dirigible balloon, now being constructed in Paris. 1200 w. Revue Technique—Aug. 25, 1904. No. 65130 D.

The "Lebaudy II." Emile Guarini. An illustrated article describing this airship and giving an account of its recent breaking from its moorings and upward flight. 1300 w. Sci Am—Sept. 24, 1904. No. 65084.

MINING AND METALLURGY

COAL AND COKE.

Canada.

The Development of Coal Mining in Canada. William Blakemore. A report on the abundance of coal in most parts of Canada, and its effect on the industries. 1500 w. Can Min Rev—Aug. 31, 1904. No. 64840 B.

Coal Testing.

The Coal Testing Plant of the Survey. E. W. Parker. Illustrated description of the plant at Louisiana Purchase Exposition. 3500 w. Eng & Min Jour—Sept. 15, 1904. No. 64992.

Coke.

The Manufacture of Coke in Peru. J. Morgan Clements. Brief illustrated description of the method of coking. 500 w. Trans Am Inst of Min Engrs—Sept. 1904. No. 65264.

Coke Plant.

The New No. 3 Coke Plant of the Oliver & Snyder Steel Co. An illustrated description of a complete modern plant and its equipment. 1200 w. Mines & Min—Sept., 1904. No. 64883 C.

Coking.

The Installation of an Underfired Coke-Oven Plant (Die Inbetriebsetzung einer Unterfeuerungs-Koksofenanlagen). Alois Czermak. Describing the operation of a by-product coke oven designed for a hard-coking coal. Two articles. 3000 w. Oesterr Zeitschr f. Berg u Hüttenwesen—Aug. 27, Sept. 3, 1904. No. 65140 each D.

Colliery.

The South Wilkes-Barre Colliery. Illustrates and describes one of the most gaseous mines in the anthracite region, the general plan of working, means of ventilation, and precautions to prevent mine fires. 1800 w. Eng & Min Jour—Sept. 22, 1904. No. 65206.

Cumberland Gap.

The Cumberland Gap Coal Field. George H. Ashley. An illustrated article describing this area, its geology and development. Map. 2200 w. Min Mag—Aug., 1904. No. 65201 C.

Exhibits.

Coal Mining at the Louisiana Purchase Exposition. Illustrated description of models showing works of some of the large bituminous coal companies. 2500 w. Mines & Min—Sept., 1904. No. 64885 C.

Gob-Fires.

The Problem of Gob-Fires. George Farmer. Read before the Inst. of Min. Engrs. Deals with spontaneous combustion and the problem of gob-fires, their cause, prevention, and extinction. Discussion. 4500 w. Ir & Coal Trds Rev—Sept. 16, 1904. No. 65251 A.

Peat.

Possibilities of Peat as Fuel. Describes recent methods used in Germany for utilizing peat and other waste products as fuel. 1500 w. Sci Am—Sept. 10, 1904. No. 64916.

Pinxton Collieries.

The Applications of Electricity at the Pinxton Collieries. Describes the extensive application of electricity in these English collieries. Ills. 4200 w. Elect'n, Lond—Sept. 9, 1904. No. 65030 A.

Safeguards.

Safeguards in Bituminous Coal Mining. W. E. Fohl. Considers that the laws regulating the mining of bituminous coal need regulating and offers some suggestions, urging particularly the need of uniformity. Discussion. 11000 w. Pro Engrs' Soc of W Penn—July, 1904. No. 65052 D.

Tipples.

The Use of Steel for Coal Mine Tipples, and a Classification of Same. George S. Rice. Discusses the various questions relating to coal tipples, from an experience in the western part of the United States. Ills. General discussion. 11000 w. Jour W Soc of Engrs—Aug., 1904. No. 65093 D.

Virginia.

The Big Stone Gap Coal-Field of Virginia and Kentucky. J. L. Pultz. Describing a district which is developing into an important centre for the production of furnace coke. 3500 w. Engineering Magazine—October, 1904. No. 65195 B.

COPPER.

Mining Methods.

Mining Methods in the Vermilion and Mesabi Districts. Kirby Thomas. A general description, with illustrations, of the methods used in these mines of copper and iron. 4000 w. Min Wld—Aug. 27, 1904. No. 64729.

Montana.

The Casual Observer at Anaconda. Charles S. Palmer. Illustrated brief description of this copper reduction plant, the largest in the world—The Washoe smelter. 2500 w. Eng & Min Jour—Sept. 22, 1904. No. 65209.

Lake Superior.

Peculiarities of Lake Superior Copper Production. Horace J. Stevens. A summary of the interesting features of this region, with map. 3500 w. Min Wld—Aug. 27, 1904. No. 64730.

GOLD AND SILVER.

Amalgamation Test.

Testing Gold-Ores by Amalgamation. Ernest A. Hersam. Considers methods of amalgamated iron, especially describing a method by which the amalgamated gold is to be recovered, weighed and thus determined directly. 10000 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 65262 C.

Assaying.

A Crucible Charge for Gold and Silver in Zinc Ores. E. J. Hall and E. Popper. A report of investigations made to eliminate troubles in the scorification method of assaying zinc ores for the precious metals. 500 w. Sch for Mines Qr—July, 1904. No. 65057 D.

Fire Assaying. Evans W. Buskett. Describes the apparatus commonly used and the methods, the reagents, and some of the reactions. Ills. 2800 w. Mines & Min—Sept., 1904. No. 64884 C.

The Determination of Silver in the Sulphide Ores and Concentrates of the Slocan. D. Lay. A comparison of pot and scorification assays. 2000 w. B C Min Rec—Sept., 1904. No. 64895 B.

Briquetting.

A Bricking Plant for Flue Dust and Fine Ores. Jas. C. Bennett. Illustrates and describes the plant for briquetting ores at the Selby Smelter, San Francisco. 1100 w. Eng & Min Jour—Sept. 15, 1904. No. 64993.

Chile.

Notes on the Gold District of Canutillo, Chile, S. A. Sydney H. Loram. A descriptive account of the development of a district but little known. Ills. 4000 w. Trans Am Inst of Min Engrs—Feb., 1904. No. 65259.

Cyanide.

Cyaniding in the Black Hills. J. T. Milliken. A description of the process practiced at the Imperial mine. 2000 w. Min & Sci Pr—Sept. 10, 1904. No. 65021.

The Cyanide Practice of the Cripple Creek District. G. E. Wolcott. An account of the practical application of the cyanide process in this district. The present outlook seems favorable, but it has only been in use about one year. 1800 w. Min Rept—Sept. 1, 1904. No. 64834.

Mexico.

The Taviche Mining District near Ocotlan, State of Oaxaca, Mexico. H. M. Chance. Brief review of the history of these mines, the methods of working, etc. The ores are siliceous, consisting principally of quartz carrying gold and silver. 2200 w. Trans Am Inst of Min Engs—Sept., 1904. No. 65260.

Milling.

Notes on Mill Construction Milling and Amalgamation. Discussion of paper by J. Roskelly. 4200 w. Jour of the Chem Met & Min Soc of S Africa—July, 1904 No. 64953 E.

Mother Lode.

The Mother Lode in Tuolumne County, California. W. H. Storms. Illustrated description of the geological and mineralogical characteristics of this gold-bearing formation. 1500 w. Min & Sci Pr—Sept. 17, 1904. No. 65223.

Nevada.

The District of Goldfield, Nevada. Marshall D. Draper. Illustrated description of a mining camp that has marketed over $700,000 worth of ore in about seven months though poorly equipped. 2000 w. Eng & Min Jour—Sept. 8, 1904. No. 64,903.

New Zealand.

Milling and Treatment of Auriferous Ores in New Zealand. H. A. Gordon. Abstract of a paper in Trans. of the Aust. Inst. of Min. Engrs. Describes the ores and the treatment given them. 6500 w. N Z Mines Rec—June 16, 1904. No. 64951 B.

Water in the Hauraki Gold-Field, New Zealand. Percy Morgan. Information in regard to these mines where water is always encountered immediately below the drainage level of the surface and requires the use of pumps. 1800 w. Eng & Min Jour—Sept. 15, 1904. No. 64994.

Ore Deposits.

The Geology of the Treadwell Ore-Deposits, Douglas Island, Alaska. Arthur C. Spencer. A description of the Treadwell gold-deposits in their geological aspects, with an outline of the general geological features of the region. Ills. 13000 w. Trans Am Inst of Min Engrs—Oct., 1904. No. 65258 C.

Precipitation.

Electrical Precipitation in Montana. Matt. W. Alderson. An illustrated description of this method of treatment adopted to overcome difficulties in securing perfect precipitation. 1200 w. Min & Sci Pr—Aug. 27, 1904. Serial. 1st part. No. 64825.

Queensland.

Notes on Tin, Copper, and Silver Mining in the Stanthorpe District. Lionel C. Ball. An illustrated article, the present number deals with methods of tin mining. 8800 w. Queens Gov Min Jour—July 15, 1904. Serial. 1st part. No. 64849 B.

The Carters Towers Mines. S. Horsley. Report on their ventilation and sanitary arrangements. 6600 w. Queens Gov Min Jour—July 15, 1904. Serial. 1st part. No. 64850 B.

Roasting.

Chloridizing Roasting of Silver Ores in Mexico. Ernest Stein. Describes the working of the reverberatory furnaces. 2300 w. Eng & Min Jour—Sept. 1, 1904. No. 64767.

Sampling.

The Sampling of Ore as Practiced in the Cripple Creek District. C. E. Wolcott. Describes the methods practiced in one of the greatest gold camps, where sampling is of particular importance. 1300 w. Min Rept—Sept. 8, 1904. No. 64934.

Siberia.

Gold Mining in Siberia. J. H. Curle, in the London *Economist*. Information concerning these mines, and a discussion of racial, political and economic reasons why the writer considers them unfavorable for foreign investments. 1500 w. Eng & Min Jour—Sept. 15, 1904. No. 64997.

Slimes.

The Separation of Sands from Slimes. From Bulletin No. 7, of the South Dakota School of Mines. Describes the method used. 1500 w. Min Rept—Sept. 15, 1904. No. 65046.

Smelting.

The Custom Smelting Industry in Mexico. James W. Malcolmson, in the *Lead and Zinc News*. On the growth of the silver-lead smelting industry in Mexico, and the advantages of copper matte over lead as a vehicle for the concentration of gold and silver contained in silicious ores. 1500 w. Can Min Rev—Aug. 31, 1904. No. 64842 B.

Sulphides.

The Potter Process. Donald Clark. Illustrates and describes a machine for the separation of sulphides from gangue by this process. 1400 w. Eng & Min Jour—Sept. 8, 1904. No. 64907.

Thunder Mountain.

Notes on Thunder Mountain, Idaho. Brief descriptions of the mines and camps of this region. 3000 w. Eng & Min Jour —Sept. 8, 1904. No. 64906.

Tube Mills.

The Tube Mill in the Transvaal. An account of results of tests being made on the Rand. The experiments have been so successful that there is reasonable expectation of increasing the production, improving the extraction, and lowering the cost. 1800 w. Engr, Lond—Sept. 9, 1904. No. 65040 A.

Witwatersrand.

The Klerksdorp District. T. Lane Carter. Information of interest concerning this district. Ills. 1400 w. Eng & Min Jour—Sept. 22, 1904. No. 65207.

IRON AND STEEL.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

England.

A French View of the English Iron Industry. E. de Billy and J. Milius, on *Revue de Metallurgie*. Considers the natural conditions under which the industry has developed, the features of the different districts, and British equipment and organization. 2500 w. Ir Age—Sept. 1, 1904. No. 64787.

Ferro Alloys.

See Electrical Engineering, Electro-Chemistry.

Hematite.

Brown Hematite Deposits of Eastern New York and Western New England. Edwin C. Eckel. A study of the deposits in the counties of Dutchess and Columbia. N. Y.; Berkshire, Mass., and Litchfield, Conn. Ills. 2800 w. Eng & Min Jour—Sept. 15, 1904. No. 64996.

Iron Ores.

The Analyzing and Grading of Iron Ores. Edward A. Separk. Abstract of a paper prepared for the meeting of the Lake Superior Min. Inst. Describes the methods used with the ores of the Oliver Iron Mining Co. The samples are taken underground. 2500 w. Eng News—Sept 1, 1904. No. 64797.

See Industrial Economy.

Limonite.

The Genesis of Limonite Ores in the Appalachians. F. Lynwood Garrison. A geological study. 2800 w. Eng & Min Jour—Sept. 22, 1904. No. 65208.

Metallography.

Notes on Metallography. William Campbell. On the present methods of research, particularly in iron and steel. 8500 w. Sch of Mines Qr—July, 1904. No. 65059 D.

The Plastic Yielding of Iron and Steel. Walter Rosenhain. Read before the Iron & Steel Inst. Deals with the lines of argument advanced by various writers in recent papers, examining the evidence on which their views are based. 3300 w. Engng—Sept. 9, 1904. Serial, 1st part. No. 65038 A.

Methods.

Modern Methods of Making Iron and Steel. Brief review of the history, showing Pennsylvania's part in their introduction. 2000 w. Bul of Am Ir & St Assn—Sept. 10, 1904. No. 64874.

Mexico.

Some Notes on the Cerro Mercado. Oliver Cummings Farrington. Illustrations and information of this hill in Mexico, which is largely made up of solid iron ore. Considers its origin, the uses made of the ore, etc. 2000 w. Eng & Min Jour—Sept. 1, 1904. No. 64766.

Nickel Steels.

See Mechanical Engineering, Materials.

Ontario.

The Exploration of the Ontario Iron Ranges. A. B. Willmott. Read before the Can. Min. Inst. Discusses the surface indications of undiscovered iron ore deposits, and the best methods of exploration. 3000 w. Can Min Rev—Aug. 31, 1904. No. 64841 B.

Pig Iron.

Some Examples of Irregular Distribution of Sulphur in Pig Iron. John J. Porter. Read at the A. F. A. convention. Describes some very remarkable cases of segregation of sulphur found in analyzing a large number of pigs of iron. 600 w. Foundry—Sept., 1904. No. 65067.

Russia.

The Iron Industry of Russia (Russische Eisenindustries). A review of the present output of iron and steel, with data as to costs and quality. Two articles, 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 13, 20, 1904. No. 65136 each D.

Scandinavia.

Iron Ore Mining in Scandinavia. W. Fischer Wilkinson. Abstract of a paper read before the Inst. of Min. & Met., England. On the character and extent of the deposits, considering Dunderland, Kirunavaara, and Gellivara. Map. 3000 w. Ir Age—Sept. 1, 1904. No. 64786.

Slag.

The Granulation of Blast-Furnace Slag (Zur Granilierung der Hochofenschlacke). R. Schöffel. A discussion as to the influence of the water upon the granulation of slag discharged into it. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 20, 1904. No. 65139 D.

Steel Works.

Notes on American Steel Works. David E. Roberts. Illustrated notes dealing principally with details which seem to the writer of practical interest, and confined to rolling mills. 1800 w. Engng—Sept. 9, 1904. Serial. 1st part. No. 65036 A.

MINING.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Columbia.

Mining in British Columbia. Arthur Lakes. Describes the country, mining districts, labor conditions, etc. The deposits are gold, silver, copper, lead and zinc. Ills. 1700 w. Min Rept—Sept. 15, 1904. No. 65045.

Conveyor.

The Aërial Ropeway at Aberfeldy. Illustrated description of a new aërial ropeway in Scotland, for the conveyance of stone from the quarries, a distance of 2¼ miles. 600 w. Engr, Lond—Sept. 2, 1904. No. 64965 A.

Electric Pumping.

A French Electrically-Operated Mine—Pumping Installation. Frank C. Perkins. An illustrated description of a recently installed plant in Belgium. 700 w. Min Rept—Sept. 22, 1904. No. 65234.

Faulting.

Faulting at Ballarat East. T. S. Hart. Calls attention to the nature of the movement on the dip-faults, and the effect on the disposition of the rich ore. 3800 w. Aust Min Stand—July 28 and Aug 4, 1904. Serial. 2 parts. No. 64852 each B.

Outcrop.

Field Notes. Prof. Arthur Lakes. Concerning ore shoots and the influence of down-hill pressure on the outcrop of veins. Ills. 2400 w. Mines & Min—Sept., 1904. No. 64886C.

Quarries.

Economic Points in Quarry Practice. O. H. Howarth. Remarks on the action of explosives, and methods of estimating the direction and amount of rock pressure. 5000 w. Mines & Min—Sept., 1904. No. 64879 C.

Respiration.

The Latest Improvements in Artificial Respiration. Apparatus (Die Jüngste Entwicklung der Atmungsapparate). G. A. Meyer. An account of the improved respiration devices, using oxygen and absorbing the carbonic acid by caustic potash. The trials in the Shamrock mines are described. 10,000 w. Glückauf—Sept. 3, 1904. No. 65144 D.

Rock Drills.

Trials of Rock Drills. J. B. Carper

Data on trials showing relative air consumption per cubic inch of rock drilled by different makes of drills. 3500 w. Mines & Min—Sept., 1904. No. 64881 C.

Sampling.

Mine Sampling. G. W. Miller. On sampling, testing and valuing of ores, their classification, requirements of a mine examiner, etc. Ills. 1800 w. Ores & Metals —Sept. 1, 1904. Serial, 1st part. No. 64820.

Shafts.

Sinking Through Quicksand at the Susquehanna Mine. H. B. Sturtevant. Read before the Lake Superior Min. Inst. Describes the methods used and progress made. Ills. 1500 w. Eng & Min Jour—Sept. 1, 1904. No. 64765.

The Lining of Old Shafts with Reinforced Concrete (Eisenarmierte Betonausbau alter Schachte). Ant. Schimitzek. Describing the successful replacement of old timbering with reinforced-concrete lining. 1000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 20, 1904. No. 65138 D.

Signalling.

Mine Signalling by Compressed Air. Describes the pull bell system in general use, and gives an illustrated detailed description of the compressed air signal system which is a modification of the system used on express trains. 2500 w. Ir & Coal Trds Rev—Sept. 2, 1904. No. 64966 A.

Timbering.

Timber and Timbering. J. H. Batcheller. Describes the methods in use at the Bunker Hill and Sullivan mines, in the Coeur d'Alene district, of Idaho. Ills. 1700 w. Eng & Min Jour—Sept. 15, 1904. Serial, 1st part. No. 64995.

Traction.

Electric Gathering Locomotive. An adaptation of the ordinary trolley locomotive so that it may enter rooms in which wires have not been installed, is illustrated and described. 1500 w. Mines & Min—Sept., 1904. No. 64878 C.

Pneumatic Traction in Mines in the United States (La Traction Pneumatique dans les Mines des Etats Unis). A de Gennes. With illustrations of compressors and compressed-air locomotives and data as to efficiency and cost. 5000 w. 1 plate. Mem Soc Ing Civ de France—June, 1904. No. 65132 G.

Veins.

The Formation of Veins. J. F. Kemp. A brief statement of general principles, reviewing the views of noted geologists. 2500 w. Min Mag—Aug., 1904. No. 65,-200 C

Ventilators.

A Guibal Fan with Volute Casing. E. Lagage. Translated from the *Revue Universelle des Mines.* Illustrates and describes a fan installed in French mines. 800 w. Eng & Min Jour—Sept. 1, 1904. No. 64763.

Centrifugal Ventilators. R. V. Norris. On the design and tests of the Luke-Fidler colliery fan, with comparison of results and conclusions reached. Ills. 2800 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 65261.

Winding.

An Electric Winding Engine with Safety Appliances (Ein Elektrisch Anbetriebener und mit Allen Sicherheits-vorrichtungen Ausgerüsteter Förderhaspel). H. Koch. Illustrating an electric winding engine for a depth of 169 metres and a speed 5 metres per second; using a polyphase motor. 1000 w. 1 plate. Oesterr Zeitschr Berg u Hüttenwesen—Aug. 20, 1904. No. 65137 D.

Comparison Between Direct Current and Polyphase Systems for Electric Winding Plant. John G. Hooghwinkel. Deals principally with a case where there is a separate power station for the winding plant, considering the first cost of a direct current and a polyphase equipment, and pointing out the advantages and disadvantages of each. 1800 w. Elec Engr, Lond. —Sept. 16, 1904. No. 65241 A.

Computations for Electrically Driven Winding Engines (Die Berechnung der Elektrisch Betriebenen Hauptschacht-Fördermaschine). V. Graubner. Discussing the power required and the proportions for electric motors of various types. Serial. Part I. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 10, 1904. No. 65141 D.

The Hoisting Problem. James R. Thompson. Discusses the problem in regard to the underground requirements, its engineering and mechanical features, and the financial side; especially considering the Lake Superior region. 5500 w. Min Wld—Sept. 10, 1904. No. 64927.

The Problem of Dynamic Balance. E. H. Roberton. An investigation of single, double and quadruple stage winding from a depth of 4000 feet. Ills. 3800 w. Ir & Coal Trds Rev—Sept. 16, 1904. No. 65252 A.

MISCELLANY.

Asbestos.

Production of Asbestos During 1903. Joseph Hyde Pratt. On the uses of asbestos and the origin of the chrysotile variety. 4800 w. Min Wld—Sept. 17, 1904. No. 65023.

China.

The Mineral Resources and Metallurgical Processes of Northern China (Richesses Minerales et Procédés Métallurgiques du Chan-si, Chine Septentrionale). A description of the Chan-si district and its mineral resources of iron and coal. 2000 w. Génie Civil—Sept. 10, 1904. No. 65121 D.

Diamonds.

Diamond Mining in the Transvaal. From the London *Economist*. The effect of the development of the Premier Diamond Mine on the diamond market. 2000 w. Aust Min Stand—July 21,1904. No. 64851 B.

The Genesis of the Diamond. Gardner F. Williams. Describes the physical properties of the diamond; where they are found, the theories as to their origin and the weak spots in them are considered. 5000 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 65263.

Explorations.

Exploration in the Sudan and Abyssinia. A. H. Ackermann. Illustrations, with description of the country, transport difficulties, climate, labor, etc. 1500 w. Eng & Min Jour—Sept. 8, 1904. No. 64905.

Ice Sheets.

Crystosphenes. J. B. Tyrrell, in the *Journal of Geology*. An explanation of how the buried sheets of ice found in the tundra of Northern America are formed. 2000 w. Aust Min Stand—Aug. 11, 1904. No. 65238 B.

Nickel.

The Nickel Deposits of Norway. Major R. G. Leckie. Read before the Can. Min. Inst. Describes the geological formations of Norway, the ore deposits and particularly the nickel mines in the southern part. 2500 w. Can Min Rev—Aug. 31, 1904. No. 64839 B.

Petroleum.

Refining of California Petroleum. Paul W. Prutzman. Read before the Pacific Coast Gas Assn. Brief account of the production in California, describing the apparatus of a refinery and the methods used and giving much information of the products. General discussion. Ills. 10500 w. Pro Age—Sept. 15, 1904. No. 64979.

Quicksilver.

The Quicksilver Deposits of California. William Forstner. A study of the formation and characteristics of these deposits. 3000 w. Eng & Min Jour—Sept. 8, 1904. Serial. 1st part. No. 64904.

Salt.

Rock Salt Mining. W. R. Crane. Illustrated description of the deposit and the methods employed at the plant of the Royal Salt Co., at Kanopolis, Kansas. 2000 w. Mines & Min—Sept., 1904. No. 64882 C.

The Desert Dry Lakes of California. G. E. Bailey. Notes on these saline lakes and the value of their deposits, and the importance of protecting and preserving them. 2200 w. Min & Sci Pr—Aug. 27, 1904. Serial. 1st part. No. 64826.

Tungsten.

Tungsten Ores in the Black Hills. Jesse Simmons. Information concerning these deposits and their mode of formation. 1300 w. Min Rept—Sept. 1, 1904. No. 64835.

Zinc.

Hedburg's Simplex Process for Separating Refractory Zinc Ores. Robert T. Clegg. Illustrates and describes a plant for separating iron sulphide from zinc blende. 1500 w. Min Wld—Sept. 10, 1904. No. 64928.

Notes on the British Columbian Zinc Problem. Alfred C. Garde. Extract from a paper used before the Canadian Mining Institute. Information concerning the mines and ores and their treatment. 1700 w. B C Min Rec—Sept., 1904. No. 64894 B.

The San Juan Country as a Zinc Producer. Samuel W. Osgood. Information concerning the zinc mines of the Rocky Mountains. Ills. 1800 w. Min Wld—Sept. 17, 1904. No. 65022.

See Electrical Engineering, Electro-Chemistry.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Collisions.

A Panacea for One Class of Butting Collisions. H. W. Forman. Considers the present method of moving trains on a very busy single track railroad, with suggestions for insuring greater safety. 2000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64778.

Long Run.

A Long Run Without a Stop. H. A. B. Campbell. Gives running time of the trains between London and Plymouth, with remarks on the service. The distance is 246 miles and the grades severe. 1300 w. R R Gaz—Vol. XXXVII. No. 14. No. 64998.

Train Rules.

An Explanation of Form F. An explanation and discussion. 2200 w. R R Gaz—Vol. XXXVII. No. 14. No. 65003.

MOTIVE POWER AND EQUIPMENT.

Auto Car.

The Ganz Rail Auto Car. An illustrated description of a car designed by Ganz & Co., of Budapest. 800 w. R R Gaz—Vol. XXXVII. No. 12. No. 64774.

Braking.

Braking High-Speed Trains. R. A. Parke. Claims that materially increased stopping efficiency may with propriety be employed in high-speed train service. Assumes the use of the automatic air brake. 2400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65265 D.

Car Ventilation.

The Passenger Car Ventilation System of the Pennsylvania Railroad. Outlines the system adopted, after much experimental work. Ills. 2500 w. Eng Rec—Sept. 24, 1904. No. 65228.

Coupler.

The Westinghouse Automotic Air and Steam Coupler. Illustrated description of this interesting exhibit at St. Louis. 1200 w. R R Gaz—Vol. XXXVII. No. 14. No. 65002.

High Speeds.

High Speeds on Steam Railways (Les Grandes Vitesses sur les Chemins de Fer). R. Bonnin. Describing some of the steam locomotives recently designed in Germany for the attainment of high speeds. 3500 w. Revue Technique—Sept. 10, 1904. No. 65131 D.

Locomotives.

Atlantic Locomotive for the Wabash. Illustrated description. 400 w. Ry Age—Sept. 9, 1904. No. 64900.

A Western Pioneer. J. A. Baker. Illustration, with information concerning a Stevens engine on the Southern Pacific. 500 w. Loc Engng—Sept., 1904. No. 64799 C.

Experiments and Observations Made on the Locomotives of the Danish State Railway. O. Busse, in the *Organ für die Fortschritte des Eisenbahnwesens.* 2000 w. Bul Int Ry Cong—Aug., 1904. No. 65082 F.

Four-Cylinder Compound Locomotive. Illustration, with brief description of the engine at the St. Louis Exhibition representing the Von Borries balanced system. 1200 w. Engr, Lond.—Sept. 9, 1904. No. 65042 A.

High-Speed Tank Locomotive for Mountain Service (Schnellzug-Tenderlocomotive für Gebirgsbahnen). Describing a four-cylinder compound engine with superheater for heavy mountain service, built by Henschel & Son, of Cassel, Germany. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Aug. 27, 1904. No. 65108 D.

High-Speed Three-Cylinder Compound German Locomotive. Illustrated description of an engine on exhibition at St. Louis which is entirely inclosed above the running board in a continuous steel housing wedge-shaped at the front end, for the purpose of reducing air resistance. 2200 w. Ry Mas Mech—Sept., 1904. No 64930.

Locomotive for the Londonderry and Lough Swilly Railway. Illustrated detailed description. 900 w. Engng—Aug. 26, 1904. No. 64868 A.

Modern Locomotives at the St. Louis Exposition. A double-page engraving of a series of the more interesting exhibits, with remarks on the various types. 2500 w. Sci Am—Sept. 17, 1904. No. 64986.

New Type of Compound Locomotive, Adriatic System, of Italy. Drawings and description of novel engines of excellent efficiency. 1300 w. Ry & Engng Rev—Sept. 10, 1904. No. 64926.

Passenger Locomotive. Michigan Central Railroad. An illustrated description of a 4-6-2 (Pacific) type. 1000 w. Am. Engr & R R Jour—Sept., 1904. No. 64791 C.

Suburban Engine for the Long Island Railroad. Brief illustrated description of a suburban tank locomotive of the Prairie or 2-6-2 type. 500 w. Loc Engng—Sept., 1904. No. 64798 C.

The Development of the Compound Locomotive in England. W. E. Dalby. Professor Dalby's second article deals with the compound engines of the Northeastern, Midland and Great Northern railways, with details and data of performances. 3000 w. Engng Mag—Oct., 1904. No. 65192 B.

The New Compound Locomotives of the Paris Belt Line (Les Nouvelles Locomotives Compound du Chemin de Fer de Ceinture, à Paris). F. Barbier. Illustrating and describing the four-cylinder, tandem, compound engines designed by M. du Bousquet for the special service of the Paris belt line. 2000 w. 1 plate. Génie Civil—Sept. 10, 1904. No. 65120 D.

The Schenectady Super-Heater Locomotive. Brief illustrated description of the design of F. J. Cole. 1400 w. Am Engr & R R Jour—Sept., 1904. No. 64790 C.

Motor Coaches.

Steam Motor Coaches, Midland Railway. Illustrated description of the self-propelled steam railway coaches being run between Morecambe and Heysham. 1800 w. Engr, Lond.—Aug. 26, 1904. No. 64871 A.

Private Cars.

A Handsome Private Car. Illustrated description of a fine car built for exhibition at St. Louis. 700 w. Ry Age—Sept. 9, 1904. No. 64902.

Steaming.

Investigations Upon the Steaming Capacity of Locomotives and the Composition of Flue Gases (Rauchgasanalysen und Verdampfungsversuche an Lokomotiven). H. Strahl. A study of combustion and steaming in locomotives, with the practical application of the Orsat apparatus to the flue gases. Two articles, 9000 w. Glasers Annalen—Sept. 1, 15, 1904. No. 65147 each D.

Superheating.

See Mechanical Engineering, Steam Engineering.

Train Lighting.

The Prussian System of Electric Train Lighting. Herr Carl Roderbourg. Describes the system of electric lighting adopted. 2500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65304 D.

Train Pipes.

To Detect Fall of Pressure and Stoppages in Train Pipes. Thomas J. Quirk. An illustrated description of an air-brake mechanism intended to prevent loss of pressure from any cause. 1000 w. Loc Engng—Sept., 1904. No. 64800 C.

Trucks.

Flange Wear and Side Bearing Trucks. Gustav Lindenthal. Read before the N. Y. R. R. Club. Also editorial. An investigation of the wear of wheel flanges and of the inside flange of the outside rail of curves and the remedy. Ills. 5700 w. Eng News—Sept. 22, 1904. No. 65092.

NEW PROJECTS.

Alaska.

A Year's Work on the Alaska Central Railway. A. W. Swanitz. An illustrated account of this project and the progress made. 1200 w. Eng News—Sept. 8, 1904. No. 64910.

Spain.

Trans-Pyrenean Railways. Outlines schemes for constructing three lines, two of which will include long international tunnels. Map. 700 w. Engng—Sept. 9, 1904. No. 65037 A.

PERMANENT WAY AND BUILDINGS.

China.

The Railways of Southern China (Eisenbahnen in Südchina). N. Post. A review of the development of railway construction in the vicinity of Canton, with maps. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 9, 1904. No. 65152 D.

Grades.

Grade Reduction, Omaha and Springfield Divisions, Illinois Central R. R. J. C. Gray. Notes on the best practice in grade reduction, with illustrations of work. 1300 w. Ry & Engng Rev—Aug. 27, 1904. No. 64728.

Interlocking.

Electric Interlocking of Switches and Signals at Antwerp Central Station. L. Weissenbruch. A review of the development of mechanically operated switches, the various systems, with illustrated detailed description of this installation and much information of interest. 26300 w. Bul Int Ry Cong—Aug., 1904. No. 65078 F.

Profile.

The Railway Profile Considered with Reference to Propelling Power. Prof. William D. Pence. Condensed from a paper read before the Indiana Engng. Soc. Calls attention to fundamentals connected with the operation of locomotives and trains needed to be understood by the civil engineer having charge of line construction. 1600 w. Eng Rec—Sept. 10, 1904. No. 64937.

Rails.

Effects of Annealing on Steel Rails. Thomas Andrews and Charles Reginald Andrews. Gives results of experiments showing the effects produced by annealing and also some indication of the physical effects produced by treating steel rails when shipping them in connection with various permanent way arrangements. 4200 w. Am Mfr & Ir Wld—Sept. 22, 1904. No. 65098.

Reconstruction.

Rebuilding a Great Railroad. Frank H. Spearman. An account of reconstruction work, introducing novel methods, straightening tracks, rebuilding bridges, etc. 2500 w. World's Work—Oct., 1904. No. 65256 C.

Shops.

The Sedalia Shops of the Missouri Pacific. Illustrated detailed description of shops under construction. 1500 w. Ry Age—Sept. 23, 1904. No. 65235.

Signal Batteries.

Signal Batteries in Summer. H. S. Balliet. Discusses troubles due to the expansion of porcelain and glass and the evaporation of solutions. 1000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64777.

Signaling.

Railroad Signaling. G. E. Ellis. Discusses the general principles of railroad signaling and types used. Ills. 9000 w. Jour W Soc of Engrs—Aug., 1904. No. 65094 D.

Signals.

A New System for the Protection of Trains by Engine-Cab Signals. Emile Guarini. Illustrates and describes a device invented by MM. Pfirmann and Wendorf, which gives an audible signal in the cab. It requires a third rail. 1000 w. Sci Am Sup—Sept. 24, 1904. No. 65086.

Lightning and Automatic Block Signals. H. S. Balliet. Describes interruptions due to lightning, considering their origin and the methods employed to control such troubles. 1500 w. R R Gaz—Vol. XXXVII. No. 13. Serial. 1st part. No. 64915.

The Electric Lighting of Railway Signals (Elektrische Beleuchtung von Eisenbahnsignalen). A. Frey. Describing the system of incandescent lamps used with the signal system on the St. Gothard Railway, in Switzerland. 2000 w. Elektrotech Zeitschr—Aug. 11, 1904. No. 65180 B.

Slip.

Draining and Steadying Slips. Illustrates and describes the treatment of such troubles by British engineers. 700 w. R R Gaz—Vol. XXXVII. No. 13. No. 64914.

Special Tools.

Special Tools in the Elkhart Shops of the L. S. & M. S. Ry. Illustrated descriptions of a number of interesting special appliances to facilitate the progress of work. 2500 w. Ry Mas Mach—Sept., 1904. No. 64929.

Terminals.

New York Terminal Station of the Pennsylvania. Illustrations from photographs of the model at the St. Louis Exposition, with explanatory notes. 400 w. R R Gaz—Sept. 23, 1904. No. 65211.

Ties.

Further Use of Steel and Reinforced Concrete Ties. Information regarding recent experiments made with ties other than wood. Also editorial. 4000 w. Ry & Engng Rev—Sept. 10, 1904. No. 64925.

Report on the Question of Wooden Sleepers or Crossties (Subject I. B. for Discussion at the Seventh Session of the Railway Congress). F. J. E. Spring. A study of the causes of deterioration of wooden sleepers in tropical climates and of the method of preventing it. 23800 w. Bul Int Ry Cong—Aug., 1904. No. 65079 F.

Wooden Ties: Selection of Kinds and Processes of Preservation. M. Housser. Report to be presented at the meeting of the International Railway Congress. On the kinds of wood used, various methods of treatment, deterioration, influence of ballast and subgrade, etc. 8000 w. Ry Age—Sept. 9, 1904. No. 64901.

Tracks.

Needed Improvements in Railway Track and Maintenance of Way. Editorial comparing briefly European and American railways to the disadvantage of the latter in the matter of tracks, with remarks on the exhibits at St. Louis. 1800 w. Eng News—Sept. 8, 1904. No. 64912.

Turnouts.

A Problem in Locating Turnouts. C. M. Kurtz. States the problem and gives ready and accurate methods of obtaining solutions. 800 w. Eng News—Sept. 8, 1904. No. 64913.

Wash-Outs.

Destructive Western Torrents. Illustrates and describes some destructive effects in New Mexico, Arizona, southern California and Nevada, especially on the Atchison, Topeka & Santa Fé. 1000 w. Ry Age—Sept. 9, 1904. No. 64898.

TRAFFIC.

England.

Railway Traffic. A review of the Board of Trade returns and the effect of tramway traffic. Refers to the problem of classes to be solved in England and gives information of interest. 3300 w. Engng—Sept. 16, 1904. No. 65247 A.

Fast Freight.

Handling Fast Freight on the Canadian Pacific. Gives forms and information concerning the new method of handling fast freight on through trains, known as the "Red Card" system. 2200 w. R R Gaz—Sept. 23, 1904. No. 65210.

Pooling.

Report No. 2 on the Question of Pooling Locomotives (Subject VI. for Discussion at the Seventh Session of the Railway Congress). G. W. Rhodes. On the use of two or more crews; the advantages and disadvantages of the practice and the result of such common use with respect to the efficiency and the care of the locomotive. 6700 w. Bul Inst Ry Cong—Aug., 1904. No. 65080 F.

MISCELLANY.

Exposition.

The Exhibit of the "Big Four Route" at the St. Louis Exhibition. H. W. Hanbury. Illustration, with description of the locomotive shown and of the turntable on which it stands. 1200 w. Engng—Sept. 9, 1904. Serial. 1st part. No. 65035 A.

The Transportation Exhibits at the St. Louis Exposition (Das Eisenbahnverkehrswesen auf der Weltausstellung in St. Louis, 1904). Fr. Gutbrod. A review of the railway exhibits at St. Louis, the first portion describing the locomotive testing plant of the Pennsylvania Railroad. Serial. Part I. 6000 w. Zeitschr d Ver Deutscher Ing—Sept. 3, 1904. No. 65110 D.

Jubilee.

Jubilee on the Northeastern Railway. W. B. Paley. Outlines the history of this English road which has just completed its first half century. 2000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64775.

Norway.

The Northernmost Railway of the Earth (Die Nördlichste Eisenbahn der Erde). F. Thiess. An account of the railway from Lulea to Narvik, opening up the iron ore deposits of northern Norway, and its proposed connection with the railway system of Finland. 2000 w. Glasers Annalen—Sept. 15, 1904. No. 65148 D.

Reorganization.

The New Engineering Organization on the Rock Island System. An explanation of the present organization which places the engineering force in a position of much greater responsibility. 1700 w. Eng Rec—Sept. 3, 1904. No. 64816.

STREET AND ELECTRIC RAILWAYS

STREET AND ELECTRIC RAILWAYS.

Berlin.

Precautionary Measures on the Berlin Overhead and Underground Railway. Mr. Bork, in the *Zeitung des Vereins*. A comparison with the Paris Metropolitan Railway. 3150 w. Bul Int Ry Cong—Aug., 1904. No. 65081 F.

Boosters.

The Booster Machine in Traction Service and Its Proper Regulation. Prof. Dr. Rasch. A discussion showing that the most suitable regulation of the buffer machine is to be effected by means of speed regulation. 3000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65310 D.

Cars.

Maintenances of Electric Cars and Their Equipment. H. A. Benedict. Read before the Utica convention. Discusses some of the problems in the operation of cars in large cities. 1700 w. St Ry Jour —Sept.. 24, 1904. No. 65221 C.

Relative Economy in the Operation of Long and Short Cars. W. J. Davis, Jr. Read before the Utica convention. A discussion of power consumption of cars of various sizes and weights and relative cost of operation as applying to cities of 30,000 to 50,000 inhabitants. 1400 w. St Ry Jour—Sept. 24, 1904. No. 65218 C.

Combined System.

A System of Electric Driving, Especially for Electric Tramways. (Betriebssystem für Elektrische Kraftanbagen insbesondere für Bahnen.) Dr. Johann Sanulka. A description of an electro-pneumatic system of power transmission, especially adapted for use with single-phase motors. 2500 w. Zeitschr f Elektrotechnik—Sept. 4, 1904. No. 65170 D.

Control.

Raworths' Automatic Regenerative Control. An illustrated description of this system, the apparatus and report of trials made. 3200 w. Tram & Ry Wld—Sept. 8, 1904. No. 65214 B.

Electric Railways.

The History and Development of Electric Railways. Frank J. Sprague. An interesting historical review. 8500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65269 D.

Electric Traction.

Alternating vs. Direct Current Traction. Prof. Dr. F. Niethammer. A comparison of the various electric systems with regard to first cost, operating expenses, reliability and safety in service. Ills. 14500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65267 D.

Some Early Work in Polyphase and Single-Phase Electric Traction. Bion J. Arnold. An illustrated description of the conditions surrounding the development and application of the alternating current system, with details making clear its operation. 7500 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65266 D.

Equipment.

Notes on Equipment of the Wilkes-Barre & Hazleton Railway. Describes novel features, particularly the covered third rail and the special form of collecting shoe employed. Ills. 4000 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65268 D.

Fire Test.

Car House Fire Test in Cleveland. Illustrated description of a remarkable and successful test of a fire-extinguisher outfit designed for the protection of car houses. 2000 w. St Ry Jour—Sept. 10, 1904. No. 64897 C.

Germany.

Costs and Profits of Electric Railways in Germany. Interesting statistics on the financial results which have followed the change from horse to electrical traction in this country. 2000 w. U S Cons Repts —July, 1904. No. 64743 D.

Heavy Traffic.

High-Speed Electric Railways for Freight and Passengers. R. W. Scott. A description of the Wilkes-Barre and Hazleton Railway and the Lackawanna and Wyoming Valley Railroad, being electric railways for heavy traffic in the anthracite coal region of Pennsylvania. 3500 w. Engng Mag—Oct., 1904. No. 65194 B.

Interurban.

The Dayton, Covington & Piqua Traction Company. Illustrated description of a successful electric railway in Ohio, carrying passengers and freight. 4500 w. St Ry Jour—Sept. 17, 1904. No. 65009 C.

The Future of Interurban Electric Railways. Ernest Gonzenbach. A discussion of the things necessary for the success of a road, the present conditions and the future prospects. 3000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64776.

The Indiana Northern Traction Company. Illustrates and describes an important interurban connection of 20 miles between Wabash and Marion. 1700 w. St Ry Jour—Sept. 10, 1904. No. 64896 C.

Liverpool.

The Tramway System of Liverpool. An illustrated detailed description of this very successful system, with historical notes and general information. 11500 w. Tram & Ry Wld—Sept. 8, 1904. No. 65212 B.

Main Line.

The New Haven's Electrification Plans in the Bronx. An account of improvements to be made on the New York, New Haven & Hartford between the Harlem River and New Rochelle. 1000 w. R R Gaz—Vol. XXXVII. No. 12. No. 64779.

Merchandise.

A Method of Handling Interurban Express Matter. George Dunford. Read before the Utica convention. Gives the forms and methods used in transacting business by the Utica & Mohawk Valley Electric Express. 800 w. St Ry Jour—Sept. 24, 1904. No. 65216 C.

Freight and Express Business on Street Railways. C. R. Van Etten. Read before the Utica convention. Discusses some of the things to be considered to determine whether a street railway can profitably engage in the transportation of freight and express. 1700 w. St Ry Jour—Sept. 24, 1904. No. 65222 C.

The Question of Freight. L. W. Serrell. Read before the Utica convention. Discusses the freight business on electric roads, the methods which would probably lead to a large increase in receipts, etc. 2000 w. St Ry Jour—Sept. 24, 1904. No. 65219 C.

Modern Practice.

Present Electric Railway Practice. Clarence Renshaw. Considers present practice in the generation of the electric power; in its transmission and distribution; and the operation of the cars. 3500 w. Pro Engrs' Soc of W Penn—July, 1904. No. 65054 D.

Mont Blanc.

The Mont Blanc Electric Railway (Le Tramway Electrique du Mont-Blanc). Lieut.-Col. G. Espitallier. An account of the proposed electric railway to the summit of Mont Blanc, with especial reference to the first section from Le Fayet to l'Aiguille du Goûter. 4000 w. 1 plate. Génie Civil—Sept. 3, 1904. No. 65119 D.

New York.

Early Transportation in New York. Henry E. Armstrong. An interesting review. 1500 w. R R Gaz—Vol. XXXVII. No. 14. No. 64999.

History and Physical Aspects of the New York Subway. Illustrated description; also short articles on the traffic features, signaling and power equipment. 4500 w. R R Gaz—Vol. XXXVII. No. 14. No. 65000.

Power Production and Distribution on the Metropolitan Street Railway System. M. G. Starrett. Read before the Utica convention. A description of the system which embraces all the street surface railway lines in the boroughs of Manhattan and the Bronx, New York. Also discussion. 8000 w. St Ry Jour—Sept. 24, 1904. No. 65215 C.

The Completion of the New York Subway. A brief review of this important engineering work with illustrations. 2000 w. Sci Am—Sept. 10, 1904. No. 64918.

The New York Subway. M. G. Cunniff. An illustrated description and review of the construction of this twenty-one-mile tunnel, built in about four years through a maze of pipes and sewers, under rivers, etc. 5000 w. Wld's Work—Oct., 1904. No. 65255 C.

The Rapid Transit Subway in New York City. An illustrated article reviewing this recently completed work and describing the general conditions. 3800 w. Elec Rev, N. Y.—Sept. 10, 1904. No. 64941.

Power House.

The Power House of the Interborough Rapid Transit Company, New York. Illustrated description of this plant and its equipment. 4500 w. Power—Sept., 1904. No. 64746 C.

Rails.

Rails and Joints. William H. Cole. Information based on tests and many years of experience, favoring the continuous rail. 2000 w. St Ry Jour—Sept. 3, 1904. No. 64838 C.

Records.

Important New System of Car Equipment Records for the Brooklyn Elevated Railroads. An explanation of the details of the system adopted. 4700 w. St Ry Jour—Sept. 3, 1904. No. 64837 C.

Repairing Works.

The Car Repairing Works of Liverpool Corporation Tramways. Illustrated detailed description. 2000 w. Tram Ry Wld—Sept. 8, 1904. No. 65213 B.

Shops.

A New Concrete Paint and Overhauling Shop—Philadelphia Rapid Transit Company. Illustrated description of improvements made in shop facilities at the Kensington avenue shops, especially the reinforced concrete construction and other interesting details. 4800 w. St Ry Jour—Sept. 3, 1904. No. 64836 C.

Signaling.

Block Signaling of Electric Railways with Track Circuit Control. J. B. Struble. Read before the Utica convention. Describes arrangements of alternating current track circuits for electric roads. 1000 w. St Ry Jour—Sept. 24, 1904. No. 65220 C.

Single-Phase.

Transmission and Distributing Problems Peculiar to the Single-Phase Railway. Paul M. Lincoln. Discusses maximum economy, voltage drop, insurance against accident, mechanical considerations and avoidance of undue multiplicity of stations. 2400 w. Int Elec Cong of St. Louis—Sept., 1904. No. 65315 D.

Storage Batteries.

The Use of Storage Batteries in Long Distance Railway Work. W. N. Stewart. Urging the use of the Edison battery for this work. 1600 w. Elec Rev, Lond—Sept. 9, 1904. No. 65029 A.

Toulon.

The Electric Tramways of Toulon. (Les Tramways Electriques de Toulon.) P. Cafourier. With map of the line's views in the power house and a general account of the equipment. 2000 w. Génie Civil—Aug. 20, 1904. No. 65116 D.

Trail Cars.

The Desirability of Trail Cars in City Electric Railway Service. M. G. Pavie. Abstract of report prepared for the Vienna meeting of the International Street Railway and Light Railway Association. The opinions of different companies on the use of trail cars, with comments by the writer. 1700 w. St Ry Jour—Sept. 17, 1904. No. 65010 C.

Tramway Tariffs.

Tramway Tariffs on the Continent. Francis Reverdin. Reviews the subject as dealt with in Switzerland, Germany, Italy and Belgium at various places. 10200 w. Trac & Trans—Sept., 1904. No. 64970 E.

Trolley.

A Trolley for Heavy Multiple Unit Electric Trains. Herbert I. Bennett. An illustrated description of the roller trolley used on the San Francisco, Oakland and San José Railway. 600 w. Sci Am—Sept. 17, 1904. No. 64984.

Trolley Curves.

Trolley Wire Curves for Electric Tramways. (Die Kurvenabspannung des Fahrdrahtes bei Elektrischen Strassenbahnen mit Rollenkontakt.) R. Wahle. An exhaustive discussion of the arrangement of overhead trolley wires on curves to permit satisfactory action of the contact roller. 7500 w. Elektrotech Zeitschr—Sept. 1, 1904. No. 65159 B.

Tyneside.

The Use of Electricity on the North-eastern Railway and Upon Tyneside. Charles H. Merz and William McLellan. Read before the British Assn. A short account of the most recent development in the use of electricity on Tyneside, indicating some of the main principles governing the cheap generation and distribution of electricity for industrial purposes. Ills. 2500 w. Engr, Lond.—Sept. 9, 1904. No. 65044 A.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m*. Brussels.
American Architect. *w*. Boston.
American Electrician. *m*. New York.
Am. Engineer and R. R. Journal. *m*. New York.
American Gas Light Journal. *w*. New York.
American Jl. of Science. *m*. New Haven, U.S.A.
American Machinist. *w*. New York.
American Shipbuilder. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w*. Rome.
Architect. *w*. London.
Architectural Record. *qr*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Sydney.
Autocar. *w*. Coventry, England.
Automobile. *m*. New York.
Automobile Magazine. *m*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Brick Builder. *m*. Boston.
British Architect. *w*. London.
Brit. Columbia Mining Rec. *m*. Victoria, B. C.
Builder. *w*. London.
Bulletin American Iron and Steel Asso. *w*. Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. Soc. Int. d Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m*. Lawrence.
Bull. Int. Railway Congress. *m*. Brussels.
California Jour. of Tech. *m*. Berkeley, Cal.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Toronto and Montreal.
Canadian Mining Review. *m*. Ottawa.
Cassier's Magazine. *m*. New York.
Cement. *b.-m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.
Chem. Met. Soc. of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Compressed Air. *m*. New York.
Comptes Rendus de l'Acad. des Sciences. *w*. Paris.
Consular Reports. *m*. Washington.
Deutsche Bauzeitung. *b-w*. Berlin.
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THE CAUSES OF ACCIDENTS ON AMERICAN RAILWAYS.

By F. W. Haskell.

American railways, which have been the world's envy in the matter of freight equipment and economical freight handling, have attained a bad eminence through the awful record of accident in the conduct of their passenger business. Mr. Haskell's thoughtful discussion deals, from a wholly American point of view, with a matter which, instead of ameliorating with time and progress, as should rightly be expected, has increased in gravity until it dismays observers on both sides of the Atlantic. We believe him to be right in seeking the explanation in fundamental tendencies, lying deep below the apparent factors of equipment and organization. We are very sure that Mr. Haskell, like ourselves, will feel more than satisfied if his argument opens a discussion which shall lead the way to a remedy of the manifest evils of the present order.—THE EDITORS.

ONE must indeed be calloused who can read without a growing sense of horror the almost daily accounts of wrecks and loss of life in our American railways. A spirit of National pride prompts us to resent comparisons between the results of the operating of American and foreign railways; but no amount of sophistry can reason away the gruesome record, nor the unpalatable fact that in our country of greatest railway development, life is, by comparison, lightly held.

The record is there for all to see. How can the slaughter be stopped? Before a remedy can be applied, the cause must be discovered—and there must be a cause.

In contemplating so tremendously serious a matter as this, it is unfortunate that the force of many otherwise able discussions on the subject is weakened by an attempt to prove too much. For instance, in a

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recent issue of the *Outlook* it was suggested that one of the causes of railway accidents was the parsimony of railway managers in refusing to provide safety devices, or refusing to buy materials of sufficient strength. In other words, that with railway managers, avarice outweighed humanity. This suggestion is an expression of that unfortunate sentiment which arrays mass against class by advancing the doctrine that the man of wealth measures blood by dollars. It is the sentiment which gave birth to the faulty saying that "corporations have no souls." That sounds well, and is literally true. But corporations are owned and managed by men who are as apt to have souls as are the men who happen to be employed by individuals. It would be difficult to demonstrate that the contemplation of suffering and death is more agreeable to the corporation or railway officer than to the average man outside of these classes.

But, eliminating all humanitarian instincts, and placing the matter on a purely sordid basis—is it not self-evident that it "doesn't pay" to save a thousand dollars in the cheapening of materials and thereby lose a hundred thousand dollars in damage claims? Railway managers are usually broad and able men, and they are as quick to see and act on this truth as would be the mass of their critics.

In an article of this kind it would be foolish to attempt to cover the entire field of accidents which are incident to railway operation. By far the greatest number of fatalities are among those who may be broadly classed as "others" or "trespassers." We have too many grade crossings, and people are too prone to use railway tracks as park ways; but this class of accident is one which requires contributory negligence on the part of the victim, and will be eliminated from this discussion.

Among train accidents there are some which may be classed as practically unavoidable. The best and strongest rail may break, and no system of track inspection can cover every foot of rail during every minute of time. Then there are causes which may be called "acts of God."

Eliminating, again, all of these causes, this discussion will be confined to that most disgraceful, because entirely avoidable, class of accidents—train collisions.

Another digression will be made here to allude to a most illogical cure for railway wrecks which has recently been strongly dwelt upon by the daily press. It has been noticed that in collisions the mortality is chiefly confined to the passengers in day coaches, while the more solidly built Pullman protects its occupants from serious harm. It is urged as a cure for this that day coaches be built as strongly as are

Pullmans. Of course such a procedure would be productive of considerable good; but the collision of two rapidly moving trains composed entirely of Pullman cars would be almost sure to result in some little discomfort to their passengers. Make strong cars. But to avoid loss of life from collision, stop the collisions.

Most railways of any importance in America are solidly built, and well equipped. The so-called standard lines have spent money lavishly in providing all the safety devices known to the profession. On some lines it would be difficult to find a place where another dollar could be expended so that it would increase the factor of safety. It is a matter of record, also, that many of the most disastrous wrecks of recent years have been on those roads which are equipped with the most elaborate systems of train-protecting devices.

Very few accidents have their prime cause in insufficient or defective material or equipment, while the vast majority of them result from errors in operating. The handling of trains is governed by the standard rules. These rules are the results of fifty years of experience; and, in their present form, are well-nigh perfect. In fact, it is almost inconceivable that an accident could occur where the standard rules have been faithfully observed.

Given then, a solid road bed, heavy rails, strong equipment, proper signals, and almost perfect operating rules; why do we have the almost daily murder of passengers from preventable accidents?

Because the admirable rules for the government of employes are habitually disregarded.

We are prone to speak with something like contempt of the average Englishman's blind slavishness to "regulations," and to compare it to its disadvantage with our superior fashion of disregarding fixed rules and using individual intelligence. But we, with our quicker intellects, kill our passengers, while the "dull-witted" Englishman carries his in safety.

The underlying cause of the frequent disregard of railway rules, is that peculiar National unrest which chafes at all restraint. In the higher official it takes the form of risking much to make a reputation of accomplishing much. In the lower grade of workman it is principally an instinctive propensity to defy authority as far as dared. And the two work together for evil.

There are many train rules which are habitually broken by train men whose superiors know of the violations. And the men who break the rules know that their superiors know it, and wink at it—so long as no accident results.

On all roads the rules provide that when a train is stopped except at a scheduled station, a flagman must go back a sufficient distance to stop any train which might overtake the first.

On the better equipped roads, the line is divided into "blocks," with signal towers or bridges every few miles. The signal is generally automatic, and shows danger if a train is between it and the next signal, and clear if the block is empty. The rules direct absolute obedience to the signals.

Now either the flagman or the block signal, if properly performing his or its function, is an absolute safe-guard. The two together should make a rear-end collision impossible—but instead of that, by dividing the responsibility, they frequently cause disaster. Some of the most disastrous wrecks of recent date have been rear-end collisions on roads having a full installation of perfected block signals. In fact, the records will perhaps show more of this class of accidents on roads equipped with block signals than on roads which are not so protected.

On lines having a dense traffic, a delay to one train may affect a dozen others. Officers who could not be bribed by wealth will wink at chances being taken which may save their division from congestion.

A heavy train is behind time and comes to a red block. That signal means that another train is somewhere on the next block—possibly three or four miles away. To obey the signal and stop, means loss of time and delay to a following train and to other trains waiting at junction points. To go ahead would almost certainly result in no damage, for the train ahead will probably get off the block before being overtaken, and will be side-tracked or will regain its headway before the next block is traversed—besides, if the following train gets too close, the flagman will be out to stop it.

A train is unexpectedly stopped between stations. The rules provide that a flagman must go back a very considerable distance. It is snowing. A long tramp means wet feet. The flagman reasons: "We will be here only a few seconds anyway. I will be called in before I can get back to my post, and then the train will be delayed while I am running back to it—besides, the block signal will hold back any following train."

These things are done habitually. I have talked to old railway men. The consensus of their statements is this: "Yes, the rules say so-and-so. But the man who gets his train in on time is the one who makes a record; and the man who, by faithfully obeying all the rules, gets in the habit of coming in late, is told that if he can't make time, some other man will. Oh! if we have a wreck, then it is up to us for disregarding rules."

Many roads having installed a perfect system of block signals, destroy its entire effectiveness by establishing the "permissive block" or "going ahead under green." By this system a following train is given discretionary power to run into a block already occupied. This permission is always coupled with the injunction that the engineer must use caution, and "at all times have his train under perfect control." But in actual operation "caution" usually means not exceeding the maximum possible speed of the engine.

I once stood by the side of a busy line, with the signal engineer of the road. This line had a complete installation of block signals. We watched a dozen heavy freights rush by at thirty miles an hour, with not a hundred yards of daylight separating any two of them. I expressed surprise at the reckless disregard of signals, and the officer said: "Freights run regardless of the blocks. We couldn't get them over the road if we kept them a block apart."

I was once riding on the rear car of a through passenger train. We were being closely followed by the second section of the train. Our section was stopped in a deep rock cut, on a sharp curve. It was a very dark night and was raining hard. I went to the rear platform, and for fully three minutes listened to the conductor and flagman swear about the weather. Finally the conductor said: "Well, I suppose you'll have to go back." The flagman started back, but had not gone two car lengths when the conductor yelled to him that was far enough. Half an hour later we reached the terminus of the division, and we had not come to a full stop when the second section rolled in on an adjacent track.

On the return trip of the same journey, I was again in the rear car. It was night, but clear. Our train stopped between stations and again I went to the rear platform. In a few minutes I heard the roar of an engine's exhaust. Then a head-light showed, the noise of the exhaust ceased, and I could hear the application of the brakes. The locomotive of the following train stopped within twenty feet of the rear of my car. I said to a brakeman: "Isn't this division equipped with block signals?" He replied: "Yes, but that is the second section of this train." I said, "Oh, I see. It doesn't hurt to be hit by another section of the same train." The brakeman said nothing but looked weary, and left me.

No accident resulted in either of these cases; but in one was a total disregard of the flagging rule, and in the other a total disregard of the block signal. In neither case was there any attempt at concealment, the clear impression being given that taking chances of this kind was all in the day's work.

A few years ago, during the night and in a dense fog, two sections of a fast train were bowling along a main track. The first section was unexpectedly stopped; and the second section was also unexpectedly stopped—about half way through the first. A dozen passengers were killed. The line was equipped with block signals, and the block was set against the second section. The engineer of the second section said in his explanation of the accident that the fog was so thick that he could not see the signal.

A very proper rule in the standard code is that the inability to see a signal where one should be, must be regarded as a danger signal, and the train brought to a full stop.

I spoke to an old locomotive engineer, and he said: "Why, my dear sir, if we followed all the rules we would never get a train in. That fellow did exactly what I would have done, and if he hadn't done it a thousand times before he would have been wiping in the round house or running a peanut stand instead of an engine."

It was reported in the press not long ago that a party of officers of a large Western system decided to test the faithfulness of their men. They went to a signal station and removed the light from the semaphore. According to the rules, the first train that came along should have stopped and asked where the light was. Twelve trains in succession passed that point at full speed; and it was rumored that the officers, fearing there would not be any men left to run their trains, let the hint go out which stopped the thirteenth train.

The examples cited above are of the disregard of rules with the implied connivance of the superior officers of the train men. It must be apparent that the mischief cannot be stopped right there. The general understanding that some rules may be broken has a far-reaching effect in the steady demoralization of the men. The sense of moral responsibility grows weaker and finally disappears. Beginning with an occasional exercise of "discretion," with the tacit consent of his superior, an engineer gradually becomes a free-lance, disregarding all restraint and violating rules which the most reckless despatcher would see the necessity of obeying.

In the rear-end collision last year, on the Central of New Jersey, the engineer of the following train disregarded the red block, the waving lanterns of two flagmen, and the tail lights of the first train, into which he plunged.

In a butting collision a few months ago, in Michigan, the engineers of the opposing trains saw each other's head-lights on a straight track, for *four miles.*

It is impossible to imagine the co-incident insanity of both engineers; and we are left with the only hypothesis that habitual contempt of orders and discipline had rendered these two men physically as well as morally irresponsible.

Every added mechanical device for the protection of trains (short of one which in spite of the efforts of the train men would automatically stop and hold a train) is an added source of danger, *until* every man connected with the train service is drilled to the point that he would murder his mother in cold blood as soon as he would disregard an order or a signal. Until personal moral fibre is recognized as being the only safe foundation for the handling of trains, the additional safety afforded by a "safety device" is more than counteracted by the resulting division of responsibility.

As I have attempted to show in this article, the vast majority of all train accidents are the results of disregard of orders; and the habitual disregard of orders results from that moral degeneration which has, perhaps unconsciously, been largely brought about by the passive, if not active, attitude of railway officers. There is, however, another cause which is a factor of considerable influence. It will be difficult to give this factor its true value, and, indeed, any mention of it is sure to be met with vigorous and indignant denial. This factor is the influence of labor organizations.

It is recognized that a law without a penalty cannot be enforced. The law, recognizing the perils attaching to certain operations, invests certain responsible men with temporary power which is almost despotic. The responsible officer in the army, the navy, or the merchant marine, has the absolute power to enforce his orders.

The disregard of a train order or signal may mean death to dozens of helpless people. A railway officer should have the power not only to make rules, but to enforce them; and to enforce them, he must have the absolutely unhampered right to inflict penalties—the nature of these penalties being suspension or discharge. There was a time when the discharge of a railway employee by his division superintendent was final. No one ever thought to question it. No doubt there were some unjust dismissals, and personal spite probably played an unfortunate part. But, on broad grounds, an occasional injustice to an individual is of slight moment as compared to the safety of the traveling public and the great body of train men. And, at the worst, the proportion of unjust charges was probably very small. In the general march of progress, however, there has come about a refinement in the sense of justice, which has reached railway officers as well as other people, and with the present universal right of appeal it is almost impossible for a man to receive his final discharge unless he deserves it.

Because of these changed conditions which safe-guard the employee's tenure of employment, there is no general principle nor specific reason why the disciplining of train men should not be absolutely in the hands of their employers, without the possibility of outside interference.

On many roads, the slighest discipline, for any reason whatever, even for disregard of train orders, is habitually and persistently combatted and resisted by labor organizations. Of course, the personal equation comes in here largely, and many "locals" of labor unions are in the hands of inelligent and responsible men. But, as a matter of form, a "committee" calls to get the reason for the discharge of a fellow unionist. If the cause is sufficient, that sometimes ends it. But frequently the soundness of the reason is disputed; at other times it is recognized, but the official is urged to let the man off "just this time." In extreme cases the reasons are recognized, but the official is ordered to restore the man anyway, or stand a strike. Naturally enough, extreme cases of interference bring their own correction, for when an abuse becomes intolerable it is rebelled against. But, as in the causes spoken of earlier in this article, the great evil of "union" interference is directly apparent in the undermining of the moral sense.

A superintendent who knows that every attempt at discipline will involve him in a dreary discussion with a silver-tongued or obstinate spokesman of a committee, grows very weary, and is apt, for this reason, to disregard minor infractions of rules, where if he felt entirely free he would insist upon the maintenance of standard.

A train employee who knows that a committee will always act as a buffer between himself and his superior, becomes indifferent to exact obedience of rules.

To sum it all up: The cause of a vast proportion of our railway accidents is disregard of rules.

The disregarding of rules is the result of a moral degeneracy on the part of both train men and their superiors.

The moral degeneracy is the result of a criminal willingness to take chances on the part of officials, which has been communicated to their subordinates; and to laxness of discipline both on the part of the official and the men.

The cure for this is the cultivation of a sense of moral responsibility, upheld by the most absolute and exact discipline.

It may be claimed that the causes which I have suggested are obscure and remote, and that the proposed cure is visionary and, by its nature, impractical. That to revise the moral natures of an army of train employees is an utopian dream; and that its accomplishment would require a generation of training.

Unfortunately, such criticism would include much truth; but the nature of the disease with which we are contending is such that it cannot be cured "while you wait." We have no aching tooth to be pulled out; but polluted blood and debilitated nerves which must be slowly coaxed back to a healthy condition. If the railway carnage could have been stopped by the introduction of some mechanical device, or by the changing of some operating rule, the conditions which have afforded the reason for writing this article would have passed by years ago.

The train rules as they now exist are adequate to cover practically every point in train movement, and they require very little in the way of amendment or addition. Men who habitually disregard existing rules, will hardly give closer attention to revised rules; and a careless or a wicked man cannot be made a careful or a good man by legislation. But in order to offer a little that is concrete among the much which is abstract, I submit the following suggestions for

Supplementary Train Rules

A. No train employee may be required, *nor permitted,* to be on duty for a longer period than 12 consecutive hours; nor to be on duty for more than 14 out of any 24 hours; and every train employee must be relieved of duty for a period of at least 8 *consecutive* hours out of every 24 fours.

B. Before actually commencing duty, every train employee must sign a declaration that he has actually had sufficient sleep during the preceding 24 hours to prevent the possibility of his sleeping or being incapacitated by fatigue while on his run; and every employee who signs such a declaration falsely, shall be guilty of a misdemeanor. (The obstacles in the way of enforcing such a rule as this, would be almost insurmountable. The object of the rule is to prevent an engineer who may have spent his lay-over at his society lodge, or in nursing his sick wife or child, from going out on his run in such a condition that he might sleep at his post. Sympathy for the man in trouble should not be permitted to endanger a hundred lives).

C. No employee having the right to govern the movement of trains by telegraph, or who, as operator, sends or receives messages giving train orders, may be permitted to be on duty for more than 8 consecutive hours, nor for more than 12 in any 24 hours.

D. No meeting or passing points for trains where either train is obliged to leave the main track, shall be made except at places having a telegraph office and an operator on duty.

E. A train having arrived at a point at which it is to meet an extra or irregular train, or more than one train or section of a train of any kind, may not proceed until it has received a written clearance from the operator at the point of meeting.

F. When it becomes necessary to run a train between the different sections of another train, the sections which run behind the interposed train shall lose their designations as sections of the original train, and shall be run as specials or as sections of some other regular train whose time they may have fallen back to. That is, under all circumstances, all trains which are designated by the same number must be kept immediately together.

The violation of any train rule should be punishable by law; and if such violation results in accident causing death, the violator should be held as guilty of manslaughter.

The taking of any risk, even though not specifically covered by rule, and even though not followed by accident, should be severely disciplined.

When such a device has been developed to the point of reliability, all road locomotives should be equipped with head-lights capable of throwing a strong vertical ray. This might, in some cases, prevent collision at night—the vertical ray being discernible* where curves or other obstructions would prevent an ordinary headlight being seen.

I will venture to touch upon one other subject which may seem to be concerned wholly with the economy of operation, but which I shall endeavor to show, has a material bearing on comparative safety.

It is self-evident that so long as every train is exactly on time, a collision is impossible. It is equally evident that as trains depart from their schedule, and special orders become necesary, the possibility of collisions enters as a factor, which increases in value as the train movements become more irregular. It therefore follows that any practice which tends to disorganize the regularity of train movement is an element of danger, and should be corrected.

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* It is of course understood that practically all roads require that the head light be covered when the engine is standing on a siding, thus avoiding any doubt whether the opposing train is or is not occupying the main track. The same rule, of course, would govern the vertical ray.

Perhaps the most ordinary cause of throwing a whole division off its schedule is the breaking in two or stalling of freight trains, or their general inability to maintain time, and this largely arises from the devotion of too much zeal to the accomplishment of one idea.

Under the old-school railroad man, railroading was not a science. The operating department got cars over the road, and did not concern itself particularly with the cost of doing it. It was the rule-of-thumb method of the so-called practical man. A few years ago, theory, which had so long been held in contempt, entered the field. Some thoughtful man realized that engines and crews were being run without much regard to the effective work accomplished; and the economic principle of "tons per train mile" became the most talked-of thing in railway operation.

Now, a period of transition is always fraught with danger, and when a lot of hard-headed, practical men become inoculated with a theory, their mental vision is apt to act like a search light which has become fixed in one position—illuminate one object, and engulf all else in darkness.

"Tons per train mile" became the one goal; and the superiority of a road or its manager was measured by its or his ability to haul more tons with one engine than could be done on a rival road.

This new fetish had good effect. It cut down grades, straightened curves, and stimulated a new line of thought. But it developed monstrosities in locomotives. It taxed each engine to its full, and frequently to more than its capacity. It put breaking strains on drawbars, increasing the liability of the breaking in two of trains. It decreased the speed of freight trains and rendered their stalling a more frequent occurrence. And all of this meant a disarrangement of the schedule in all branches of the service.

In calculating the power of an engine, it is not sufficient to consider simply cylinder area and steam pressure, but piston speed must also be included. The effectiveness of a machine is not measured by the work done, but by the work done in connection with the time required to do it.

"Tons per train mile" is an incomplete, and therefore comparatively valueless exponent of work accomplished.

An engine which hauls 1,000 tons over a division in five hours is manifestly a greater revenue producer than is an engine which takes

1,500 tons over the same division in fifteen hours; and yet the second engine has made the better showing on the "tons per train mile" exhibit.

"Ton miles per engine service hour" is the true measure of efficiency.

Every piece of machinery has, somewhere, an ideal point of highest efficiency, where the volume of work and the speed are in perfect equilibrium. An engine when working at materially under or over its normal load, is not being operated economically. Applying this law of physics to railway operation:—to send a locomotive over the road with one or two cars is a waste of energy which cannot be compensated by the great speed made possible; while to load a locomotive to its limit results in a waste of time which cannot be compensated by the volume of work done.

I believe that in many cases, if the load rating of engines were decreased from 10 per cent. to 20 per cent., the gross work accomplished would be greater, wear on men and equipment would be lessened, schedules would be more closely adhered to, and one element of danger would be eliminated.

SMELTERS AND SMELTING PRACTICE IN BRITISH COLUMBIA.

By William M. Brewer.

The growth and expansion of the mineral industries in British Columbia more than justify the importance attributed to them years ago in these pages, and supported by preceding articles by Mr. Brewer, Mr. Jacobs, and other authorities. The following article summarizes and brings up to date the progress made in the smelting installations of the province.—THE EDITORS.

THE history of the smelting industry in British Columbia really dates from 1888, when a small copper smelter was erected at Golden, a point on the Canadian Pacific Railroad at the confluence of the Columbia and Kicking Horse rivers. Apparently this smelter was erected only to secure a grant of land adjacent to the town, because after its completion it was never blown in. During 1889, the Kootenay Smelting and Trading Co. completed a smelting plant at Revelstoke, where the railway crosses the Columbia River about twenty-five miles northerly from the head of Arrow Lake, and commenced smelting lead ore on a commercial scale. Active operations were continued only for a short time. The works were then closed down, leaving a memento in the shape of a moulded bar of lead branded "Kootenay," which is now in the Mineral Museum in the Department of Mines at Victoria, where it is said to represent the first bar of lead smelted in British Columbia.

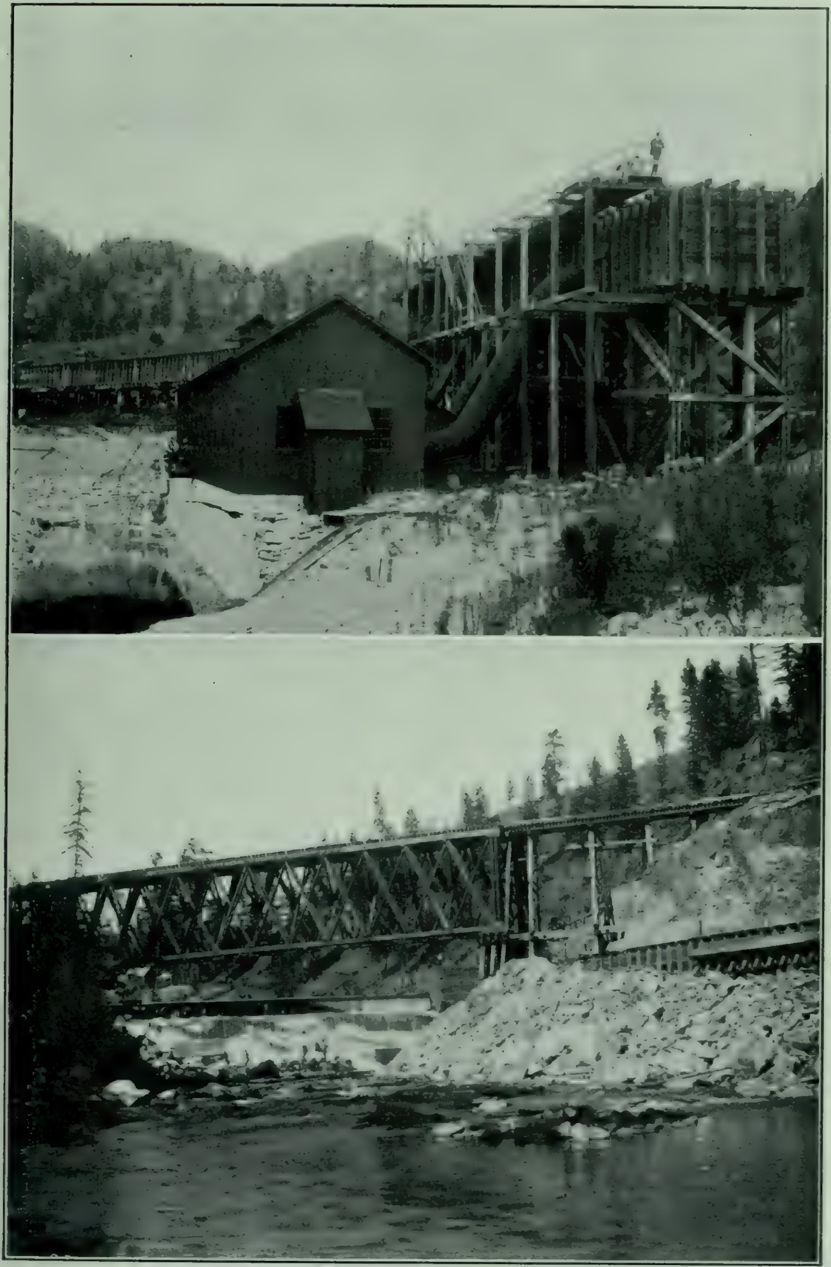
So far as can be learned, no other efforts were made to establish smelters in the province until 1891, when the site of the Pilot Bay smelter was chosen and construction work commenced. This smelter is on the shore of Kootenay Lake, about twenty miles east of the town of Nelson. Construction work was finished and the smelter put in operation early in 1895, during which year some three thousand tons of silver-lead bullion were shipped. Operations were suspended in the spring of 1896, because of the difficulty experienced in obtaining dry ores for fluxing purposes and also good coke and coal, and they have not since been resumed.

During the latter part of 1895, Mr. Paul Johnson, E. M., designed the silver-lead smelter at Nelson for an English company which owned the Silver King group of mines, about four miles in an air line from the smelter. With the completion of the construction of this smelter, the actual history of smelting on a commercial basis in British Columbia may be said to have really commenced. This plant now consists of a sampling mill, two blast furnaces, one 40 by 100 inches and another 44 by 144 inches, one mechanical double hearth, straight-line roaster and three large hand roasters, and a well equipped laboratory and assay office. The air for the blast furnaces is supplied by two blowers driven by a 100-horse-power induction motor. The sampling mill is operated by a 50-horse-power induction motor. The blast furnaces have a capacity of 180 to 200 tons of lead charge per day. The water jackets are of wrought steel. The slag is automatically removed by water granulation. The mechanical roaster is of the O'Hara type. The roasted product is mechanically conveyed to the briquette house, where it is automatically mixed with lime and passed through the briquetting machine, which forms it into bricks for charging into the blast furnaces. A complete machine shop is included in the plant.

HALL MINES SMELTER, NELSON, BRITISH COLUMBIA.

Electric power is obtained from the hydro-electric power station of the West Kootenay Power and Light Co., at Bonnington Falls, distant about eleven miles west from Nelson, and is delivered at the smelter at 550 volts.

On Oct. 10, 1895, construction work was commenced on the smelter of the British Columbia Smelting and Refining Co., of which



PLANT OF THE GRANBY CONSOLIDATED MINING, SMELTING AND POWER CO.
The upper picture shows the power house, the lower the dam, at Grand Forks.

INTERIOR OF THE POWER HOUSE, GRANBY CONSOLIDATED MINING, SMELTING AND POWER CO.

Mr. F. A. Heinze of Butte, was president, with Mr. H. C. Bellinger superintendent. This smelter is situated at Trail, a point on the Columbia River distant about eight miles from Rossland, which during the early history of mining operations in British Columbia was the leading camp in the province. This smelter as originally designed, consisted of five furnaces—four reverberatories, hearths 14 by 22 feet, capacity 40 tons each per 24 hours, and one 40-inch circular furnace, 12 feet high to feed floor, water-jacketed, with six 3-inch tuyeres, also with fore-hearth. The capacity of furnace was 45 to 55 tons of ore per day.

This smelter was erected as the result of a contract made with the owners of the Le Roi mine to treat 75,000 tons of the gold-copper ore produced from that property. At the present time it is interesting to recall some of the terms of this contract, and compare the difference between the smelter rates, charged in 1896 and those of today. The rate for freight and treatment on the first 37,500 tons of this ore was fixed at $11.00 per ton, and the rate on the remainder to be the lowest rate obtainable on the open market. Having secured this contract, Mr. Heinze, previous to erecting the smelter and building a line of railway from Trail to Rossland, arranged for a land grant from the provincial government, and a bonus from the Dominion Government of $1.00 per ton of ore smelted.

Until after the completion of the Boundary branch of the Canadian Pacific Railroad from Robson on the Columbia River to its western terminus at Midway, the Trail and Nelson smelters were the only two in operation in the province, the former treating principally the gold-copper ores of the Rossland district, together with any lead or dry silver ores obtainable, and the latter treating the silver-copper ore produced at the Silver King mine, together with any custom ores which could be secured. But since the day when these two smelters were able to meet the demand, there has been a vast change in the mining and smelting industries in the province. During the early days all the coke and coal consumed in the smelters came from the collieries on the east coast of Vancouver Island, and the cost for coke was about $12 per ton delivered. Since the completion of the Crow's Nest Pass branch of the Central Pacific Railroad, of course all fuel used on the mainland has been supplied from that field, at about half the cost price of the Vancouver Island fuel.

In 1898, Heinze sold his narrow-gauge railroad from Trail to Rossland and the Trail smelter to the Canadian Pacific Railroad, and that corporation, evidently anticipating a considerable extension of the mining industry as the natural result of the construction of extensions of their system, invested a vast sum in enlarging and improving the original plant, until today it has a capacity of 900 tons of copper ore and 400 tons of silver-lead ore, each 24 hours, while the lead refinery is capable of turning out 25 tons of pig lead per day.

The value of the entire plant when owned by Mr. Heinze was about $150,000, while the present plant is valued at approximately $1,000,000. The original plant gave employment to about 150 men, but today, when the entire plant is in operation, about 500 are employed. About 700 feet of side tracks were sufficient, in 1897, to meet the demands of the smelter; today there are nearly 3 miles required.

The motive power used in the original plant for running machinery was steam, and for handling ore between the bins, roast heaps, and the furnaces, manual labor; but after the completion of the Bonnington Falls power plant, arrangements were made for the transmission of electricity, the distance between the power plant and the smelter being about 30 miles. The line current is 20,000 volts, transformed to 550 volts at the smelter; it furnishes a total of 1,000 horse power in motors, divided into sixteen units. Of course steam has been abandoned since the installation of the electric plant, which has also supplanted manual labor for pushing tram cars, and in every other department where it is possible.

The most recent improvement introduced into this plant is that of feeding the furnaces mechanically, instead of by hand. This is done by running cars containing the furnace charge on a track along the side of the furnace, and by a mechanical device, discharging the contents of each car into the furnace in such a manner that the charge is spread in a way very similar to that which prevails by hand feeding. The first mechanical feeders used in British Columbia were introduced at the Grand Forks smelter, but differed from the method employed at the Trail smelter, because at the former a track was laid across the furnace on a level with the charging floor, and bottom-dump cars were run on this track into the top of the furnace, the contents being dumped by means of a lever attached to the car in such a way that it could be handled from the outside of the furnace. So far as expedition is concerned, this method is probably a quicker means of charging the furnace than from cars at the side, but the advantage possessed by the method adopted at Trail is said to be that the charge is more evenly spread, and does not have any such deadening effect on the heat in the furnace as results from dumping the entire charge from the bottom of the car in one mass.

On the completion of the Boundary branch of the Canadian Pacific Railroad from the Columbia River west in 1899, the construction of the following three smelters—one at Grand Forks, by the Granby Consolidated Mining, Smelting, and Power Co., Ltd., of Montreal, Quebec; another at Greenwood, by the British Columbia Copper Co.; and the third at Boundary Falls, by a company which proposed to introduce pyritic smelting—was proceeded with almost simultaneously; the two first named were completed in 1900, the Grand Forks smelter being blown in on Aug. 21 of that year, but the Greenwood not until Feb. 17, 1901, while that at Boundary Falls, although completed, was never blown in as originally designed.

Metallurgists who had made a study of the conditions in the Boundary country recognized at once that, owing to the low grade of the ore, every economical device known to the designers of smelters would have to be employed in order to ensure profits; at the same time, owing to the phenomenal extent of these low-grade ore bodies, and the fact that, through the upper levels at least, the ore was not only oxidized but carried such percentages of iron, lime, and silica as to render it self-fluxing, the same metallurgists also recognized that the question of treating the ore successfully, from a commercial standpoint, was not difficult to solve, provided smelter capacity proportionate to the producing capacity of the mines was installed. Consequently today we find in the Boundary country that the smelting capacity at Grand Forks is about 2,000 tons of ore per day; at Greenwood, between 700 and 800 tons of ore per day; and at Boundary Falls, about 900 tons of ore per day.

The Grand Forks plant comprises six double-decked, steel, water-jacketed blast furnaces, each 44 by 160 inches at the tuyeres, the furnaces arranged 39 feet apart, centre to centre; six Connersville blowers; two stands of converters, of the horizontal barrel type, with the capacity of 70 to 100 tons of matte daily; a 25-ton tilting furnace; a 40-ton electric travelling crane, 40-feet span, for handling the ladles of molten matte and the converter shells; 10-ton electric travelling crane, 24-feet span, for conveying the matte in ladles from the receivers at the furnaces to the tilting reverberatory; quartz crusher plant and grinding pan for mixing converter linings; fully equipped sampling mills, office, and laboratory.

The motive power employed is electricity, furnished through the water power developed by the company on the North Fork of Kettle River, which gives about 1,100 horse power. Besides this the smelting works are connected with the power system of the Cascade Water Power and Light Co., which is under contract to supply up to 1,000 horse power whenever required. Four double 16-inch turbine water-wheels, directly connected with alternating-current generators, comprise the generating plant. Except that steam power is employed at both the Greenwood and Boundary Falls smelters, and that at the latter no converter plant has yet been added—also that the two plants are of so much less capacity—the description of the plant at Grand Forks will serve for the others, so far as design of furnaces, machinery, and general arrangements are concerned. The slag at each of these plants is now hauled away and dumped hot, instead of being granulated, as was done as long as the dumpage facilities permitted.

Metallurgically considered, the ores of the Boundary district are the least difficult to smelt of any of the British Columbia ores, because there are absolutely no minerals or substances associated with these ores to render them difficult to treat. The ore being low in sulphur, no preparatory roasting is required, and up to the present time, no barren flux has been added to the charge. These conditions, added to the large capacity of the smelters, have led to the expression of opinions in the press that the cost for smelting in the Boundary district in British Columbia is unquestionably the cheapest extant. Any such sweeping statement as this, is in my opinion, misleading, because while the results achieved in this direction in this district have been such as to cause metallurgists in other sections considerable surprise, yet when the high cost for labor and coke in British Columbia are compared with the low cost for labor and coke in Tennessee, and it is further considered that in the Boundary district cold blast is employed as against hot blast in Tennessee, by which the quantity of fuel is reduced from about 13 per cent. as used in British Columbia, to 3 per cent. in Tennessee, it seems to me that such a statement cannot be maintained successfully.

Earlier in this article I referred to the erection of the Boundary Falls smelter by a company which proposed to introduce pyritic smelting into British Columbia, and stated that as originally designed, the plant was not operated. While these are facts, yet if it were not explained that the plant was purchased in 1902 from the original owners by the Montreal and Boston Copper Co., by whom it was remodelled, and enlarged from the small capacity for which it was originally designed, to its present capacity of nearly 1,000 tons of ore per day, the later references to this plant would be almost unintelligible.

Some idea of the smelting capacity of such a plant as that of the Granby Consolidated Mining, Smelting, and Power Co., Ltd., at Grand Forks, may be gathered from the facts set forth in the following statement published by the British Columbia Government:

> "The tonnage of ore treated during less than four years to June 30 of the current year has been as follows: In 1900, (19 weeks) 62,387 tons; 1901, 230,928 tons; 1902, 312,340 tons; 1903, 401,921 tons; 1904, (26 weeks) 312,795 tons; total, 1,320,371 tons."

Dr. Albert R. Ledoux of New York is authority for the following statements with regard to the ores of the boundary district:—

> "The average ore of the best developed mine is said to contain 38 per cent. of silica, 16 per cent. of oxide of iron, 15 per cent. of lime, about 4½ per cent. of sulphur, 1.80 per cent. copper, besides gold and silver.
>
> "The upper ores are largely oxidized, and consist of massive magnetic iron ore, carrying copper sulphide and gold. This surface ore changes, at an average depth of perhaps 25 feet, to ore in which the iron is largely combined with sulphur, or sesquioxide, rather than in the higher oxidized form. By mixing these surface ores with those from lower levels, an ideal mixture is obtained, enabling the furnaces to produce directly a 45 per cent. to 50 per cent. copper matte, carrying practically all the gold and silver which the ore contains. On the north side of the Phoenix Ravine (where the mines of the Granby company are situated) the large amount of ore developed is estimated to run about 1.80 per cent. copper,

> $2.40 per ton in gold, and 25 cents per ton in silver. The workable ores from the south side of the Phoenix Ravine contain on an average copper 1.70 per cent., gold $1.60, silver 33 cents per ton. The ore from the easterly side of the main dyke dividing the Phoenix camp probably runs by the carload about 1.60 per cent. of copper, $1.50 in gold, and 30 cents in silver. The run of the mines in the Greenwood camp (where are situated the mines of the British Columbia Copper Co., and the Montreal and Boston Copper Co.) as shown by the smelter returns, is probably 1.60 per cent. copper, $1.80 in gold, and 50 cents silver. It may therefore be taken as a safe estimate that the very large amount of ore available in the Boundary district will vary from 25 pounds to 35 pounds of copper per ton of 2,000 pounds, with from 25 cents to 40 cents of silver, and from $1.50 to $2.50 in gold per ton."

I have not at hand further details with regard to the assay value of the boundary ores, but it is generally conceded that the values which they carried when Dr. Ledoux made his examination have remained about the same, nor has the character of the ore changed to any marked degree; and when the average analysis referred to by Dr. Ledoux is considered, it can readily be understood that neither of the smelter managers found himself confronted with any difficult metallurgical problem, other than that of bringing the cost down to the very lowest possible figure.

The fact that the Granby Company has paid dividends is proof positive that this feature has received the utmost consideration of the management; in fact, the government records show that in an affidavit returned to the assessor relative to the basis for taxation, the smelting costs are sworn to as being $1.76 per ton. It is quite unlikely that the cost for treatment at either of the other smelters will vary much from these figures. It is not stated in the affidavit, though, whether in this cost is included freight and selling costs of product in the New York market. If this cost is included, as it undoubtedly should be, then the actual cost for treatment falls below the figure quoted.

The metallurgists through whose efforts such gratifying results have been obtained are A. B. Hodges, in charge of the Granby Company's works, who also designed the plant; Paul Johnson, who designed and for a long time had charge of the British Columbia Company's works, and Albert I. Goodell, who remodeled and had charge of the smelting plant for the Montreal and Boston Copper Co.

Smelting operations have been carried on in the Coast District, which includes the adjacent islands situated in British territory, since 1899, when the 50-ton smelter erected by the Van Anda Gold and Copper Co., on Texada Island, was blown in on July 15. Between that time and 1901, 17,543 tons of ore in all were treated at these works. Since then the smelter has not been operated, because it has been found to be more economical to ship the ore from the mines on Texada Island to the larger smelters on the east coast of Vancouver Island, which were erected in 1902.

The results achieved in this "baby" furnace during the time it was operated were particularly gratifying and successful, especially when all the surrounding circumstances were taken into consideration. Much of this success, however, is attributable to the character of ore treated. The great bulk of the ore was a high-grade bornite, which, although low in iron and sulphur contents, carried sufficient lime and silica for fluxing. The iron ore which was necessary to be added to the charge was supplied from deposits of magnetite occurring on Texada Island only a comparatively short distance from the smelter.

During the late fall of 1901, the production of ore from copper properties on Vancouver Island, especially on Mount Sicker in the southeastern portion of the island, attracted the attention of smelter men, with the result that a site was selected at Osborne Bay on the east coast, and the erection of the Crofton smelter by the Northwestern Smelting and Refining Co. was commenced. A few months later, the Tyee Copper Co., owners of the Tyee Mine on Mount Sicker, also erected a smelter in order to treat the product of their own mine. The Crofton smelter was established for custom work entirely, the company anticipating that it could be made a commercial success because a contract had been arranged for the entire product of the Lenora Mine, which adjoins the Tyee on the east; but owing to financial difficulties, in which the Lenora Mining Co. became involved, the mine was shut down in the fall of 1902, re-opened under a lease to the Northwestern Smelting Company in the spring of 1903, and again shut down during the spring of 1904, when the smelter also went out of blast and has not since resumed operations.

As a matter of fact, while the production of copper-gold ore in the coast district has been since 1901, and still is, sufficient to keep a 350-ton smelter in continuous operation, provided the entire production was shipped to one smelter, yet there has not been a sufficiently large production to warrant the operation of two smelters; and naturally, the one dependent on custom ore entirely would be the first to feel the consequences arising from a disregard of the law of supply and demand.

The Crofton smelter comprises three furnaces, the smallest being a 65-ton cupola for re-smelting matte, and the two larger ones water-jacketed furnaces, with a capacity each of about 350 tons per day, one of these being known as the Garretson type of furnace; two converters, with an electric carriage for handling matte ladles, converter shells, etc.; a complete sampling mill, with a total height of 80 feet, and a capacity of about 1,000 tons per day; a 10 by 20 Blake crusher; and a completely equipped modern assay office. The works are operated by steam power. There are three 200-horse-power boilers; one condenser of 1,000 horse power; blowing engine, 16 by 36 by 42; power engine, 18 by 36 by 42; two Connersville blowers, one No. 8, and the other No. 5. The dust flue is 200 feet long, 10 feet wide, and 12 feet high; the expansion chamber where the dust finally settles is 24 feet by 40 feet and 20 feet high, and the circular brick smokestack is 120 feet high, the inside diameter of the shaft being 12 feet.

All the arrangements for receiving ore, either from Mount Sicker by the narrow-gauge railway, which connects that mining camp with the smelter, or by water from other portions of the island, province, and United States, are perfect and thoroughly up to date. In fact, this plant, in all its equipments, is one of the most modern in the west.

The Tyee Copper Company's smelter was erected at Ladysmith, on the east coast of Vancouver Island, in 1902. The site selected is between the Esquimault and Nanaimo Railway and Oyster Bay, having a water frontage of about 3,000 feet. Between the railroad and deep water, which is suitable for dock purposes, there is ample room for slag dumpage for years. The ground between high-water mark and the E. and N. Railway has been laid off in terrace form, which admits of a gravity system through the works. The plant consists of:—one water-jacketed furnace, 42 by 120 inches at the tuyeres, of which there are fourteen of 6 inches in diameter; two water-jacketed forehearths; 80-horse-power return tubular boiler; 14 by 36 Reynolds-Corliss engine; No. 7 Connersville blower; 17-horse-power engine for running a 200-light dynamo; complete ore and matte sampling plants, the former being equipped with Snyder automatic samplers; and a modernly equipped assay office. The capacity of this plant is about 250 tons of ore per day.

In connection with this smelter, several improvements have been designed by the management with regard to methods of handling ore at the roast heap yard, and also for preparing the "fines," of which there is a large percentage shipped from the mine, so that they can be charged into the furnace in the most desirable form.

The improvements in the roast yard consist in the following labor-saving devices:—first, movable bridge which spans the distance between the trestles constructed along each side of the beds on which the ore is spread for open-air roasting or calcining; second, such an arrangement of the branch tramways over which the roasted ore is transported to the smelter, that although ore has to be shovelled from the roast heaps into the tramcar, it is all shovelled down because the level of the tram track between the roast heaps is so much lowered that the top of the car is at the same level as the floor of the bed on which the ore has been roasted

The movable bridge is built on wheels, and on a level 8 feet above the beds in the roast yard, so that it can be moved from bed to bed with ease; it spans the space between the permanent trestles, on which are laid the tracks from the bins in which the ore is received from the mine; the tram cars, loaded with raw ore and constructed for side dumping, are pushed from the receiving bins along the track to the bridge, switched onto it, and the car-sides are opened, allowing the ore to drop onto the bed from both sides of the bridge, while the car is in motion. So well has this automatic method of spreading the ore been found to work, that no shovelling is required except to level off the top of the heap when finished.

While in every other portion of the province where smelting operations have been carried on the metallurgical problems have been comparatively simple, yet the composition of the Mount Sicker ore is such that when the smelters were erected on Vancouver Island, the metallurgists engaged to manage them, viz., Mr. Thomas Kiddie for the Tyee Copper Co., and Mr. H. C. Bellinger for the Northwestern Smelting and Refining Co., were confronted with the solution of the following problem—the most satisfactory and economical practise to adopt for the treatment of burned ore of the following average analysis:—

	Per cent.
Iron	10.44
Zinc	8.14
Alumina	3.61
Barium Sulphate	34.08
Magnesia	trace
Lime	3.46
Silcia	22.51
Combined sulphur	7.42
Total sulphur	13.86

It is almost the only time that such a complex problem has presented itself in smelting practice, but after considerable experimenting the problem was solved by both the managers. Mr. Kiddie gives

MOVABLE BRIDGE, ROAST YARD, TYEE COPPER CO., LTD., LADYSMITH, VANCOUVER ISLAND.

the average analysis of the slags produced during the fiscal year ending May 1, 1904, as follows:—

	Per cent.
Copper	.37
Iron	17.68
Silica	33.34
Alumina	10.75
Zinc oxide	6.44
Barium oxide	26.16
Calcium oxide	7.92

The data showing the analysis of the slags at the works of the Northwestern Smelting and Refining Co. not being obtainable at this time, there is no opportunity to compare the results.

Of course if a sufficient supply of custom ores suitable in composition for fluxing purposes could have been obtained regularly, the metallurgical problem would not have been as difficult to solve; but owing to lack of development in other camps on Vancouver Island, from which suitable fluxing ores could be drawn, the bulk of the ore which has been treated, both at the Ladysmith and Crofton smelters, has been this highly refractory Mount Sicker ore.

It is interesting to note the following taken from Mr. Kiddie's report to the Company under date April 29th, 1904:—

> "Answering yours of the 27 April, 1904, I herewith enclose a statement covering the smelter operations during the last six months; during this time the furnace was in blast 123 days of 24 hours each, an average of 20

SMELTING WORKS OF THE NORTHWESTERN SMELTING AND REFINING CO., CROFTON, VANCOUVER ISLAND.

days per month, and smelted 30,703 tons of material, of which 28,290 were ore, making a daily average of 249.6 of material, and 230 tons of ore per day, from which we shipped in the form of matte 2,275,997 pounds of copper, 72,207.8 ounces of silver, and 4,592.18 ounces of gold. A general analysis of the burned ore used during this period is as follows:

	Per cent.
Iron	11.45
Silica	19.36
Zinc	6.97
Barium Sulphate	38.87
Sulphur (in sulphides)	6.56

The general analysis of the slags produced during this period, which also includes custom ores, has been already given in this article.

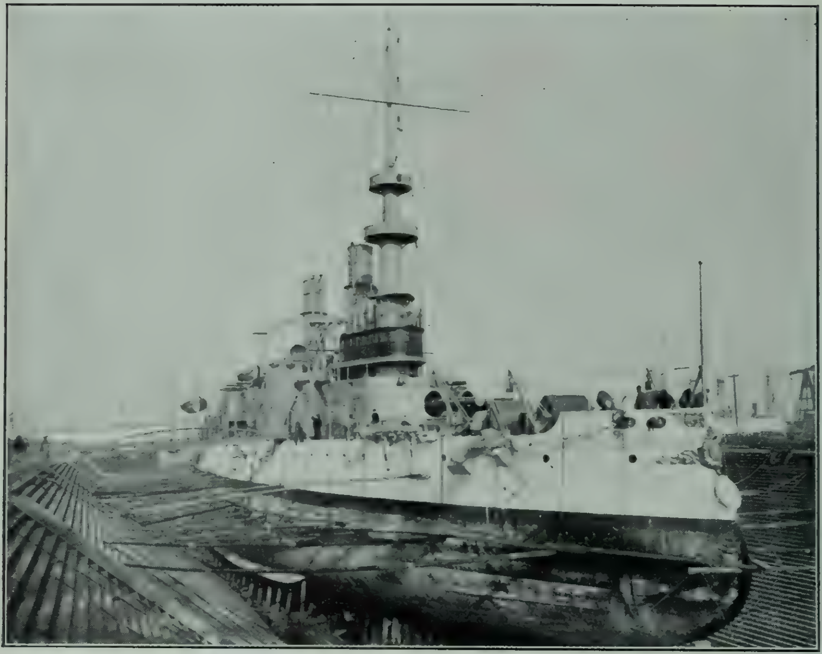
"The improvement in the slag assays for copper over the previous year is due in part to the increased settling capacity of the receivers at the furnace; in part to a reduction of the specific gravity in the slags caused by the admixture of suitable fluxing ores, which were not procurable in the earlier stages of our operations; in part to the lesser amount of zinc oxide in the slag, as a result of the admixture of other ores referred to; and in part to altered furnace practice, as a result of experiments with such ores. The specific gravity of the matte was between 4.7 and 5.0, and of the slags between 3.6 and 3.8.

"Of the total ore smelted 62.8 per cent. was burned ore, 22 per cent. raw sulphide ore, and 15.2 per cent. raw custom ore, or 62.8 per cent.

> burned ore, and 37.2 per cent. raw ore, from which a shipping matte of from 40 per cent. to 45 per cent. copper was produced in one smelting operation. Comparing the furnace work of the past six months, as shown above, with the last annual statement, it will be seen that the capacity of the furnace has been raised from 177 tons per day to 249.6 tons, an average of 72.6 tons per day."

Another question that was a difficult one to solve at the Ladysmith smelter was the best means to adopt for charging the "fines" into the furnace. The high contents of sulphur carried by these fines made it imperative that they should be roasted. After experimenting, Mr. Kiddie ascertained that by mixing the fines with ordinary brick clay, in a pug mixing machine, then moulding the product into bricks of ordinary size, and drying on a floor heated with hot air, the result was a product which not only stood handling, but which, when roasted, proved to be a most satisfactory material to charge into the furnace. It was sufficiently hard, and carried such a percentage of silica as aided in fluxing. From a commercial standpoint it is demonstrated that it is more economical to make the fines into bricks and then roast, than to roast in mechanical furnaces, and afterwards briquette the roasted ore.

The fuel used in the Vancouver Island smelters is the product of the coke ovens at Union, Vancouver Island, owned by the Wellington Coal Co. This a 72-hour coke, physically hard and compact. The average analysis of a large quantity was as follows:—volatile hydrocarbon, 6.90 per cent.; fixed carbon, 68.64 per cent.; ash, 22.10 per cent.; and sulphur, 2.30 per cent. This coke is found to be well adapted for blast-furnace work, notwithstanding the high percentage of ash.



U. S. BATTLESHIP MASSACHUSETTS, DOCKED WITH EXTRAORDINARY RAPIDITY AFTER GROUNDING OFF THE MAINE COAST, IN 1903.

THE DEVELOPMENT OF DRY-DOCK PUMPING MACHINERY.

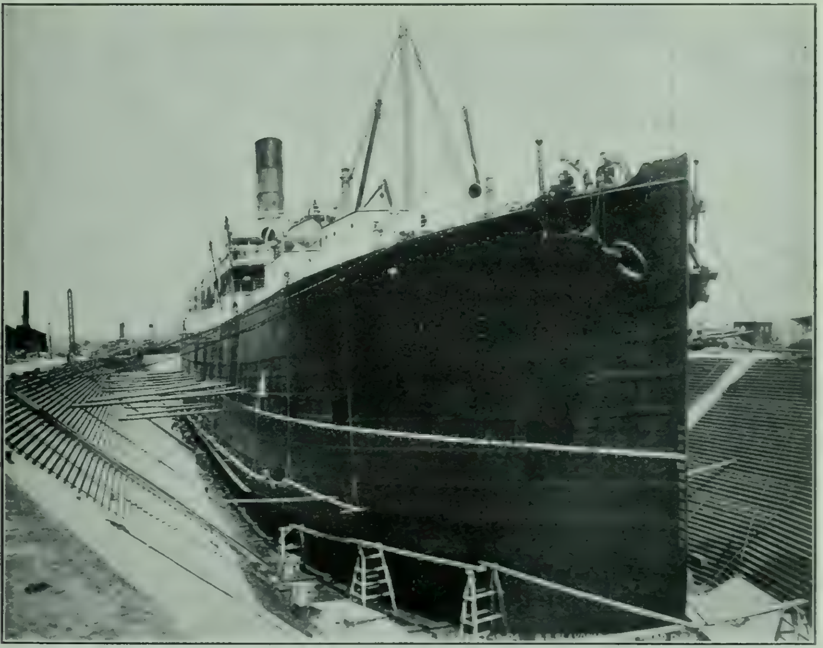
By Joseph S. Shultz, U. S. N.

THE maintenance of the highest state of efficiency and of economic operation of all maritime craft, whether their purpose be war or commerce, is dependent primarily upon the means afforded for repairs. The recent tremendous development in the freight and passenger-carrying capacities of the transatlantic steamships was possible only after adequate dock-yard facilities had been established on both sides of the Atlantic; and no nation, however ambitious or whatever the necessity, can maintain a navy unless there be coincidently installed proper shops, docks, and manufacturing plants to overhaul and equip the vessels composing it. Perhaps never has this fact been more forcibly impressed upon the public generally than by the events immediately following the first encounter between the Russian and Japanese squadrons at Port Arthur, when, had there been a carefully designed repairing plant available, the crippled Russian vessels could have been placed within a month in condition to do battle again—a circumstance which, with the aid of the Vladivostok ships, might have determined the control of the sea.

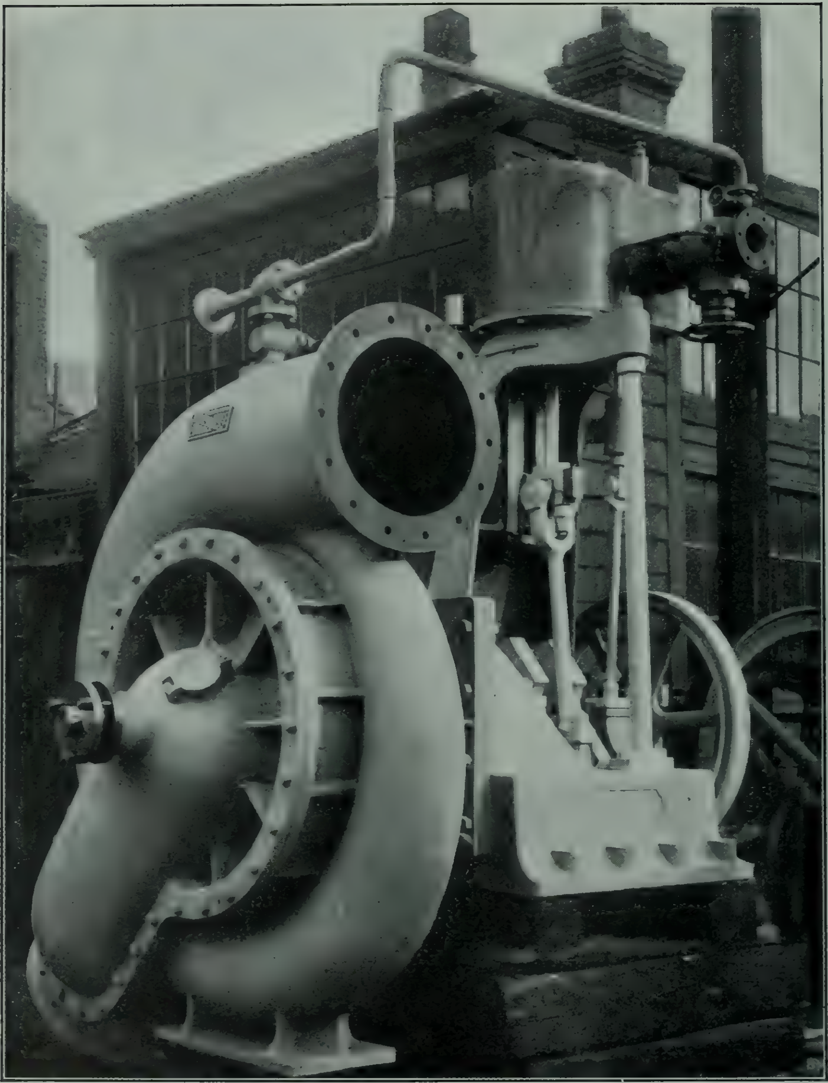
Essentially a ship-yard plant must consist of:—

1. Wharves or quay walls.
2. Traveling cranes.
3. Repair and manufacturing shops.
4. Storehouses for spare parts and equipment.
5. Dry docks.

The wharves or quay walls afford the necessary berthing space for vessels which have to undergo but slight alterations, such as replacing boiler or engine parts, painting, rearranging a portion of the interior, etc., the heavy pieces being transferred to and from the vessel by means of the cranes. Such repairs as these are most frequent, requiring but little suspension of the vessel's regular duties; but periodically—the intervals depending upon the character of the vessel and the service to which it has been subjected—there must be made a complete and thorough overhauling of the hull and equip-



CUNARD LINER SLAVONIA DOCKED IN THE NEW YORK NAVY YARD, JULY, 1904, ON ACCOUNT OF LACK OF FACILITIES IN PRIVATE YARDS.

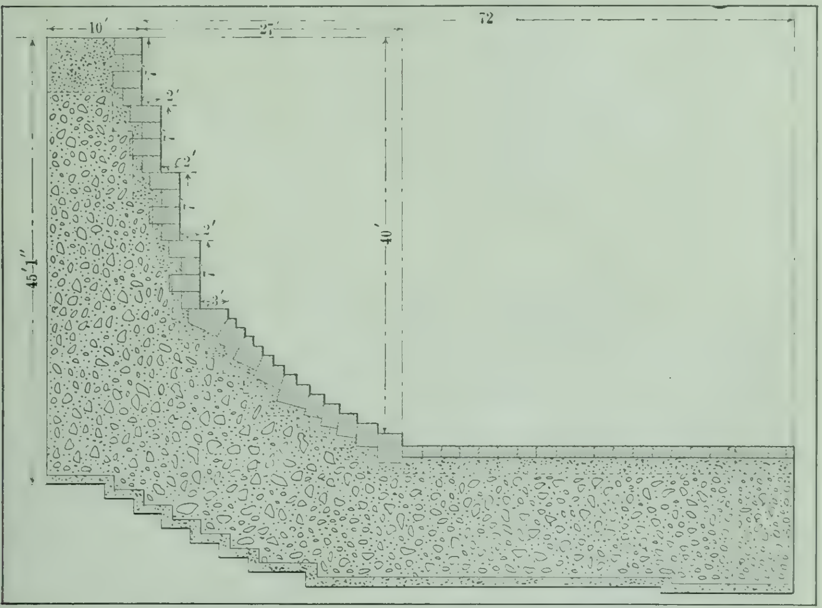


24-INCH CENTRIFUGAL PUMPING ENGINE, CAPACITY 3,000 TONS OF WATER AN HOUR, FOR A GRAVING DOCK IN THE NORTH OF ENGLAND.

Pulsometer Engineering Co., Ltd., Reading. The propeller is 40 inches diameter; specially designed blades for low-lift work. Engine of high-speed type, 16 by 20, with crank-arm balances forged in one of the crank shafts.

ment. This can be done only by placing the vessel in dock, where, by the removal of all the water surrounding it, the entire vessel is exposed and every portion may be thoroughly examined.

In addition to this periodic docking for general renovation, the same course must be followed in case of any accident causing injury to the hull below the water-line, and whenever the steering gear, shafts, or propellers may require attention. Consequently, although all of the five classes of dock-yard accessories are absolutely essential, it is obvious that the dry dock is really the most important of all; and, inasmuch as the water within the dock must be removed at least twice for every docking of a vessel, it is also evident that the pumping machinery plays a part of no small moment in the operation of the complete plant.



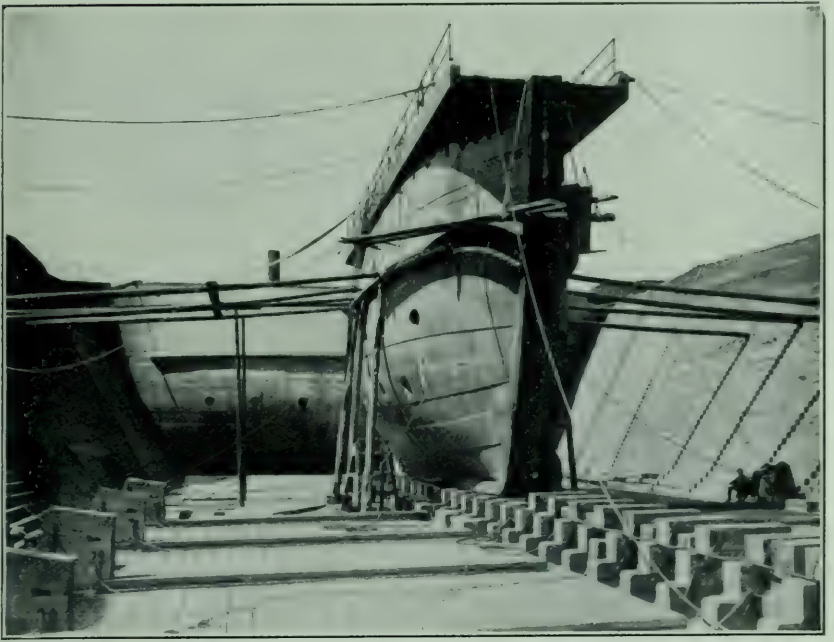
CROSS-SECTION OF ONE-HALF OF A GRAVING DOCK.

The following description of the salient features of the dock proper will aid in explaining the duties required of dry-dock pumps and the considerations governing their design.

Of the dry docks in use at the present time, there are two classes—floating and graving. The former is indispensable under certain conditions and of growing importance generally, but there are rather a small number in commission compared with the graving type, of which there are probably six hundred, ranging in value from $100,000 to $4,000,000. In general, the same kind of machinery is employed for each, but attention will be given here only to that pertaining to the graving type.

A graving dock is an excavation made to a certain depth below mean low water, lined so as to be made as nearly waterproof as possible with timber, stone, or concrete, and closed at the entrance end by a removable gate or caisson. The section is essentially U shaped, conforming to the lines of the largest vessel to be docked, with about 25 feet clearance on both sides to afford ample space and light under and around the hull. A section that may be taken as typical of graving docks is given in the illustration on the preceding page. In this basin is set a central line of keel blocks. These sustain the major part of the weight of the vessel, are spaced about 4 feet on centers, and are composed of square blocks of oak built to a height of 6 feet. On each side and distant 12 or 15 feet from the center is a line of blocks termed the docking keel blocks, inasmuch as they support the vessel near its docking keels. The tops of all of these blocks must be adjusted to fit the keel of each vessel, which necessitates the removal of all the water preliminary to every docking. Bilge blocks, sliding on racks, and spaced approximately 18 feet center to center, afford the necessary steadying power applied to the sides to keep the vessel from overturning. These are curved on their top surface to fit the hull and are

PAIR OF DAVIDSON COMPOUND ENGINES FOR HANDLING 300,000 GALLONS PER HOUR. Made for canal dock service on the Manchester ship canal by W. H. Bailey & Co., Ltd., Salford.

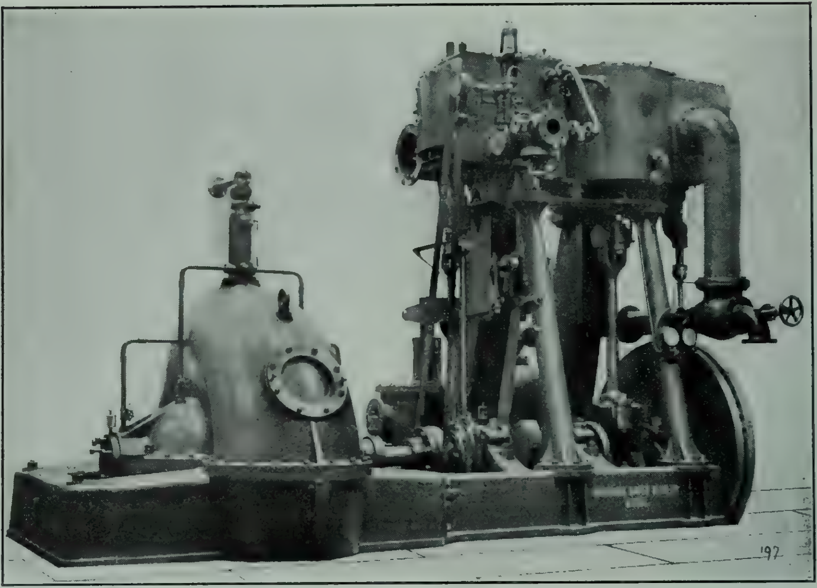


A DRY-DOCK CAISSON, DOCKED FOR EXAMINATION.

Another caisson, in position at the dock entrance, is seen in the background.

drawn in tight against the vessel by means of chains and pulleys just after it has settled on the keel blocks.

Various expedients have been employed for closing the entrance of the dock—automatic lifting gates, and double steel gates, and a single one hinged at the bottom after the fashion of similar ones used on canal locks—all of which have given way to the caisson in docks where the clearance over the entrance sill exceeds 25 feet, owing to the tremendous pressure existing and the consequent heavy construction made necessary with the above depth and a required corresponding span of over 100 feet. The caisson is a carefully designed boat with a keel on the bottom and the two ends, which rests in a groove in the dock, affording the requisite means for transferring the water pressure to the abutments of the dock and for making an absolutely water-tight closure. Through the caisson are perhaps a dozen or eighteen culverts, closed by valves, through which water is admitted to the dock when it is desired to flood it, and two inlets to the hold of the caisson itself through which water is drawn to provide the ballast required for sinking it in place in the grooves. The illustration above gives a view of a typical structure of this kind.



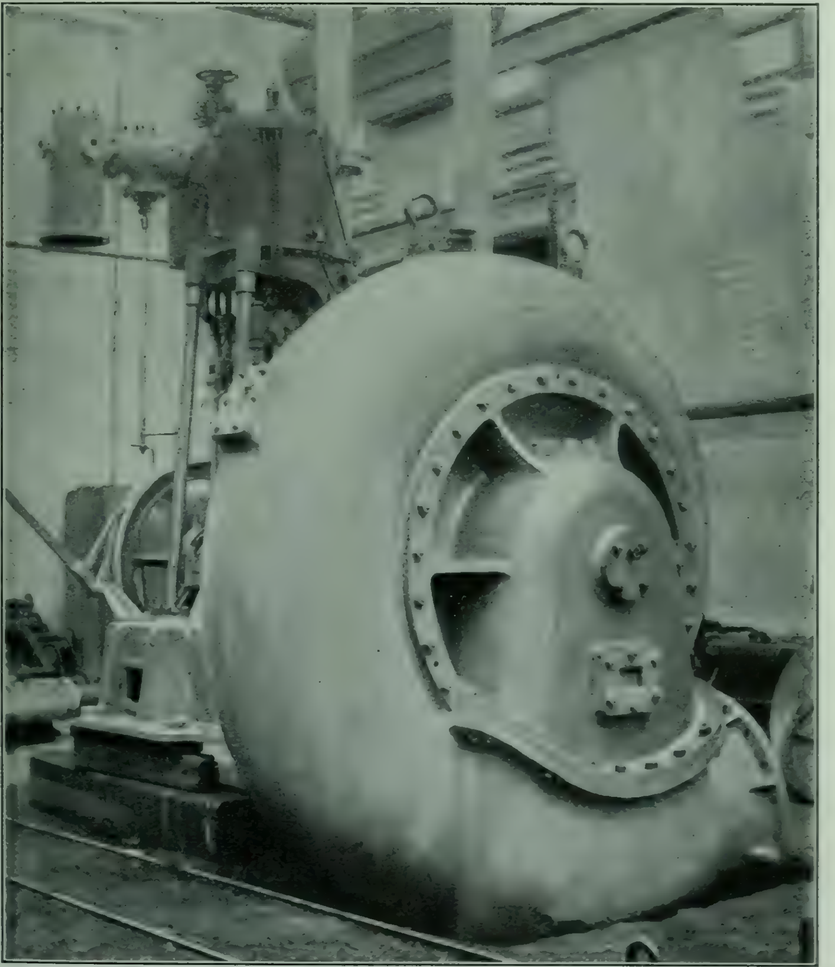
INVERTED, VERTICAL, COMPOUND, JET-CONDENSING PUMPING ENGINE WITH CENTRIFUGAL PUMP, SUITABLE FOR DRY-DOCK WORK.

Cylinders 18 and 32 inches diameter, 2 feet stroke; capable of raising 140 tons of water per minute to a height of 13 feet. By Hathorn, Davey & Co., Ltd., Leeds.

A culvert, fitted at the entrance with a rather coarse screen, so as to exclude large pieces of wood, ropes' ends, etc., conveys the water from the bottom of the dock to the well where the pumps are located. The earliest graving docks depended upon the tides for removing the water, the vessels being placed in dock during the highest spring tides; but an exception is the one described by Ptolemy, used by the Greeks in A. D., 220, which was equipped with pumping engines—he leaves us uninformed, however, as to what class of engines was employed.

It was not, however, until the eighteenth century, when the English began to strengthen their navy so materially, that graving docks of the modern type were built to any extent. In fact, the slow and expensive means theretofore employed for handling water greatly retarded development in both mining and ship-building; and, though the necessities of the former industry led directly to the invention of the steam engine, the immediate design of steam pumping engines for graving dry docks would indicate that this use, if not an actual incentive to the invention, afforded so ready and pertinent an application of the principle as to influence greatly much of the subsequent development of this new motive power.

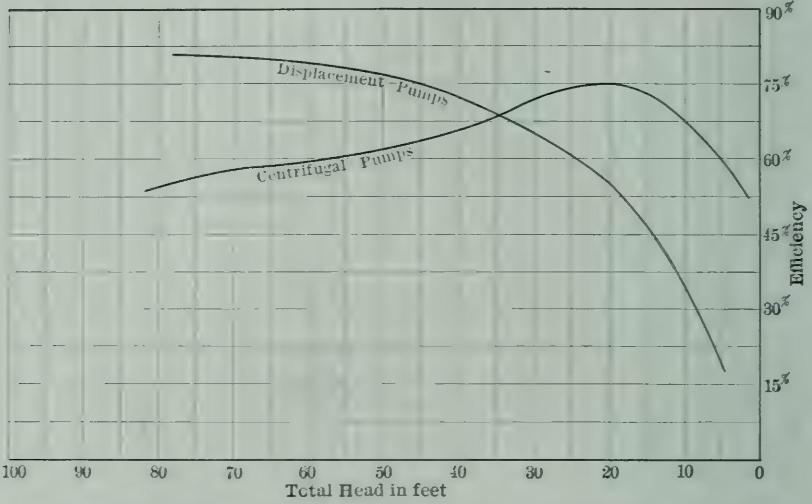
From the above time, steam-driven displacement pumps were universally used for removing the water in dry docks until about 1865, and even now some of the latest installations have been of this type—the largest, probably, being those in the Portsmouth, England, dock yard. These have plungers 72 inches in diameter with a corresponding length of stroke, are driven by compound vertical engines with cylinders 64 and 40 inches in diameter, and have a capacity of 70,000 gallons per minute with 875 indicated horse power.



ONE OF THE TWO 36-INCH VERTICAL CENTRIFUGAL PUMPING ENGINES CONSTITUTING THE PUMPING PLANT OF THE PRINCE OF WALES DOCK, SWANSEA.

Drysdale & Co., Bon Accord Engine Works, Glasgow. The plant raises 1,000,000 cubic feet of water in about 2 hours on a lift of 16 feet.

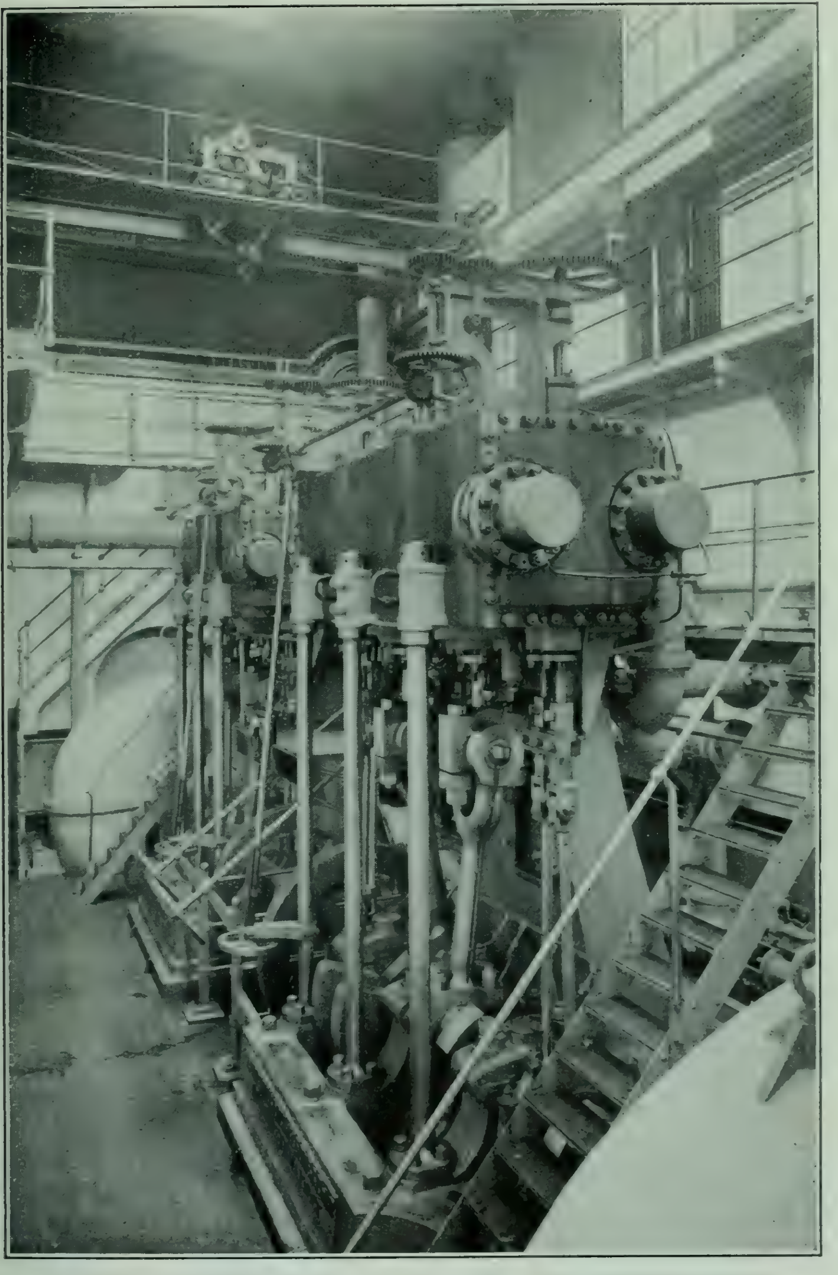
Just below there is shown a curve giving the variation in efficiency of reciprocating pumps—the abscissas being the total head in feet, and the ordinates the ratio between the water horse power (the actual water pumped) and the indicated horse power. Another curve constructed in a similar manner gives corresponding data in regard to single-stage or volute centrifugal pumps—greater efficiencies with the higher lifts being obtainable by the use of the turbine type of centrifugal pumps, or by a multiple-stage type, in which cases water can be handled very efficiently up to heads of 2,000 feet, but with comparatively small discharges.



COMPARATIVE EFFICIENCY CURVES OF CENTRIFUGAL AND DISPLACEMENT PUMPS.

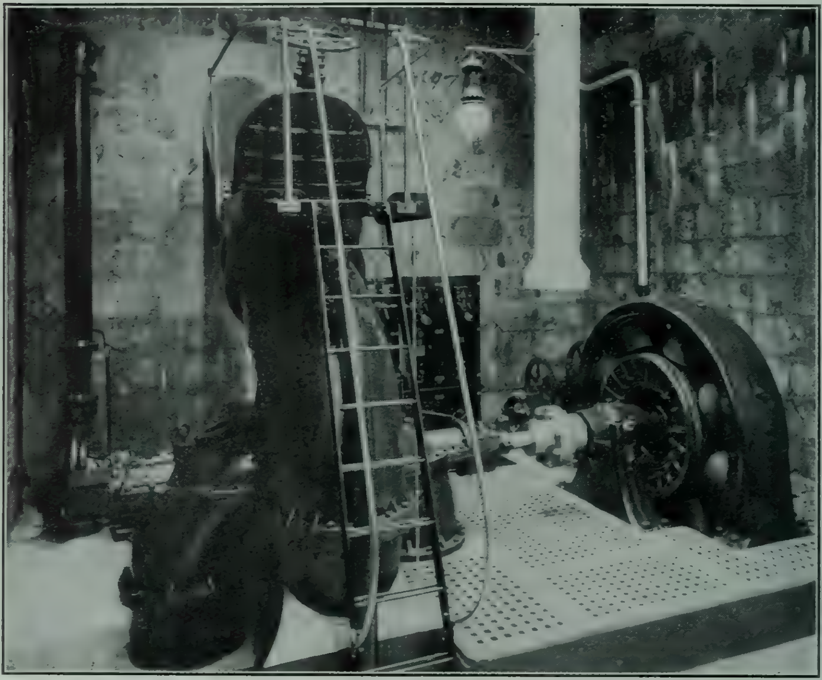
In no modern graving dock does the depth of water over the entrance sill exceed 35 feet at mean high tide, and most docks of this kind, owing to the greatly increased cost due to the heavier construction made necessary by the excessive pressure, have but 31-feet clearance, and the bottom of the main body of the dock is usually only 5 feet below the sill. Therefore the total head on the pumps for dry-dock work never exceeds 40 feet, and is in most cases less; owing, however, to the shape of the dock section in general use, from two-thirds to three-fourths of the water contained in the dock is included in the portion whose depth below mean high water is one-half (usually 17 feet) of the total depth.

With these facts in mind, it is at once evident from an examination of the above curves why the centrifugal pump has now almost universally supplanted the displacement type for this class of work.



PUMPING MACHINERY FOR NO. 3 GRAVING DOCK, CLYDE NAVIGATION TRUST.
Andrew Barday, Sons & Co., Ltd., Kilmarnock, Scotland.

Although invented in 1818 in America, it was not until half a century later that the combined skill of American and foreign engineers had produced a perfectly satisfactory centrifugal pump; but since then it has been used at low heads for lifting not only water, but mud, sand, and sewage as well.



THE FIRST ELECTRIC-DRIVEN DRY-DOCK PUMP IN THE ORIENT.

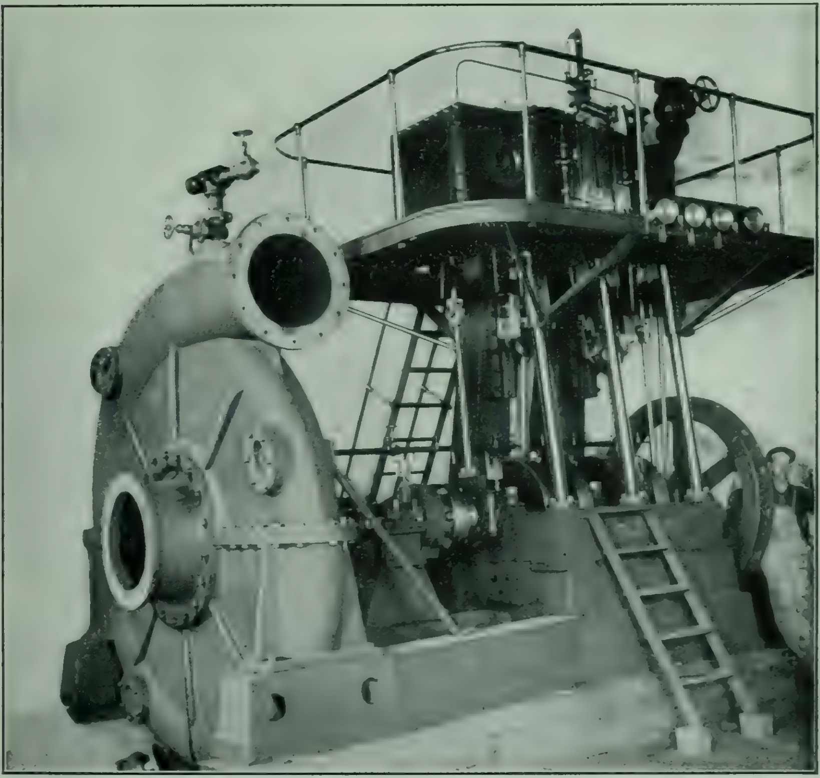
30-inch double-suction pump, direct-connected to 250-horse-power 220-volt General Electric direct-current motor. Installed at the Kowasaki dockyard, Kobe, Japan, by the American Trading Co., 1901. Built by the Lawrence Machine Co., Lawrence, Mass.

A striking illustration of the economy of this class of pumps may be had from the fact that for a capacity equal to that of the Portsmouth pumps referred to previously, and with the same head under which they operate, a centrifugal pump would use only 580 indicated horse power, against the 875 required for the reciprocating type.

It was not, however, consideration for economy alone that brought about the adoption of centrifugal pumps for dry-dock work. Their first cost is less, and owing to their simple construction they require less expenditure for repairs to moving parts and are less affected by the corrosive action of sea water. In addition to these there are three other important points of superiority:

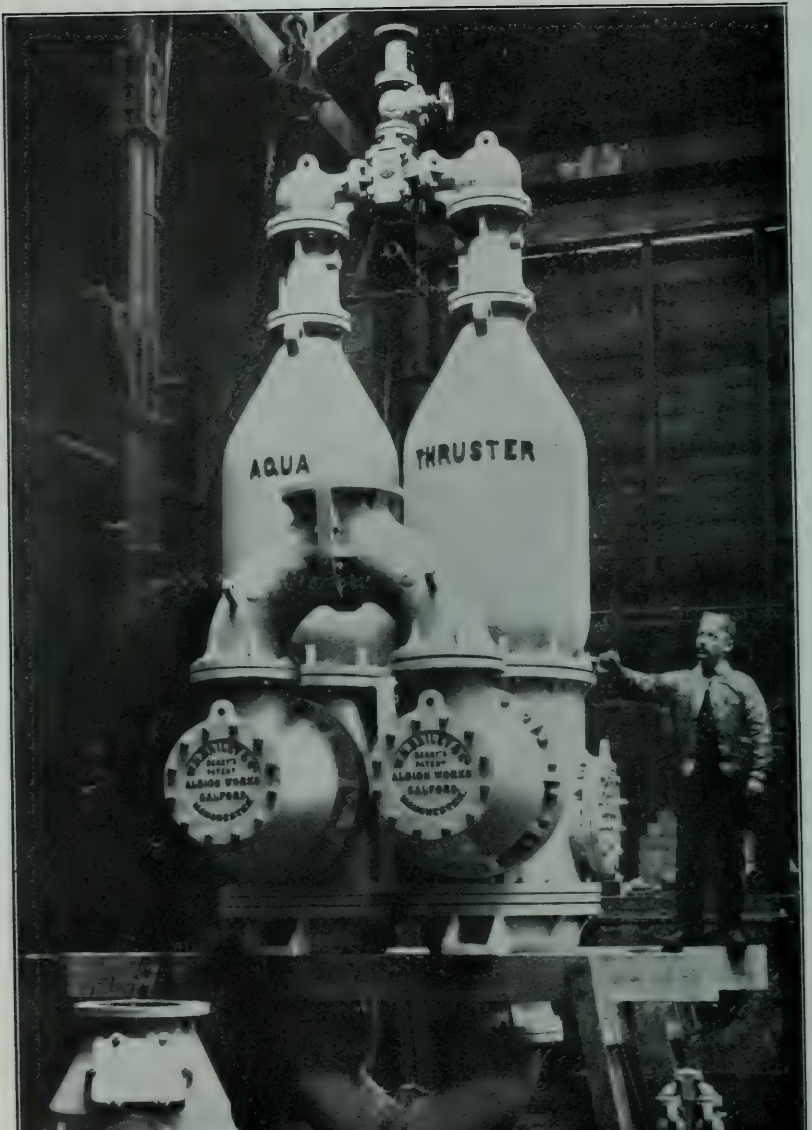
First.—The circular motion and exact balancing attainable eliminate all the vibration of displacement pumps, which is particularly harmful both to the masonry of which the pump well is constructed and that of the dry dock proper as well.

Second.—In locations where great difficulty is experienced in regard to water leakage, the engines or electric motors can be placed above the water level and connected to the pumps below in a separate chamber by vertical shafts, as was done by the Newport News Ship Building Co. in their new pumps which handle 150,000 gallons each per minute.

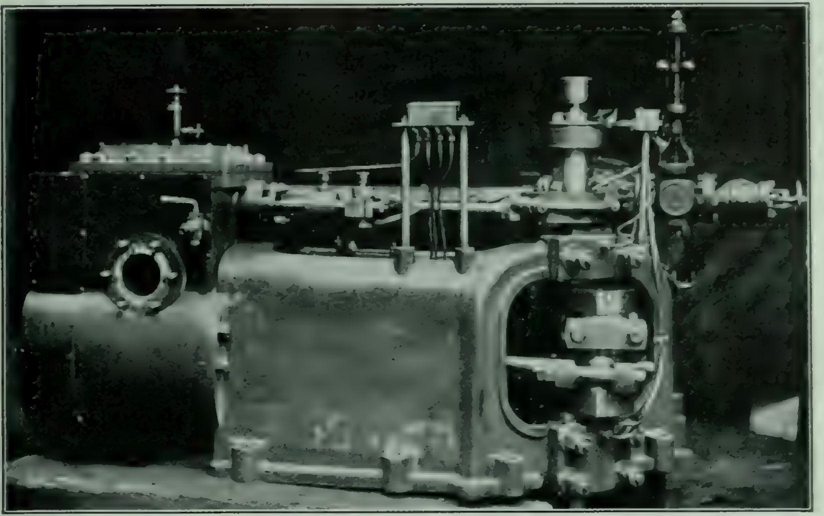


CENTRIFUGAL PUMP DIRECT-CONNECTED TO 10 BY 10-INCH DOUBLE ENGINE.
Morris Machine Works, Baldwinsville, N. Y.

Third.—The water in a dry dock always contains more or less scrapings, chips, and other rather large refuse, which will readily pass through the large water passages of the centrifugal pump, but would be caught by and clog the valves of the displacement pump.

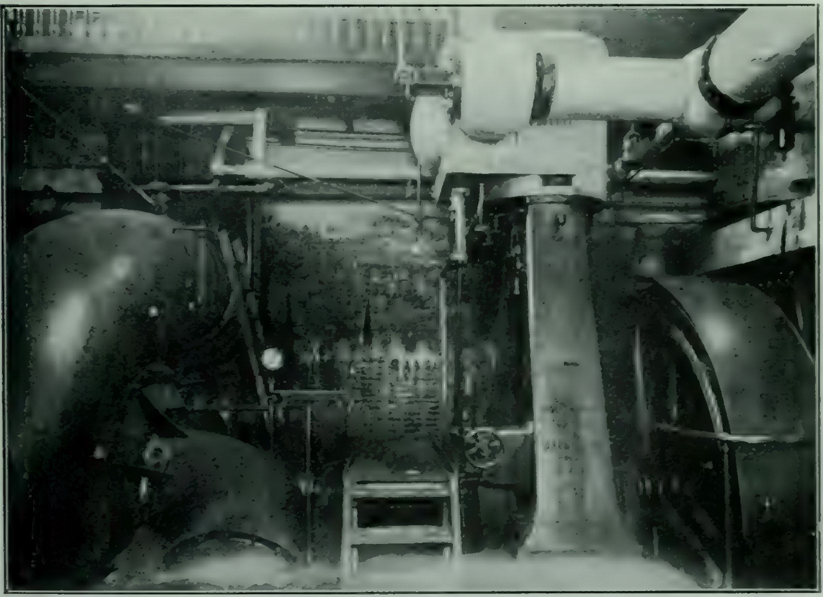


DRY-DOCK PUMPING MACHINERY FOR DEALING WITH 250,000 GALLONS PER HOUR.
W. H. Bailey & Co., Ltd., Salford.



ONE OF FOUR SETS OF COMPOUND ENGINES FOR DRIVING THE PUMPS OF NO. 2 FLOATING DOCK, DURBAN.

The pumps are placed horizontally at the bottom and driven by vertical shafting with ball bearings and flexible couplings. Drysdale & Co., Glasgow.

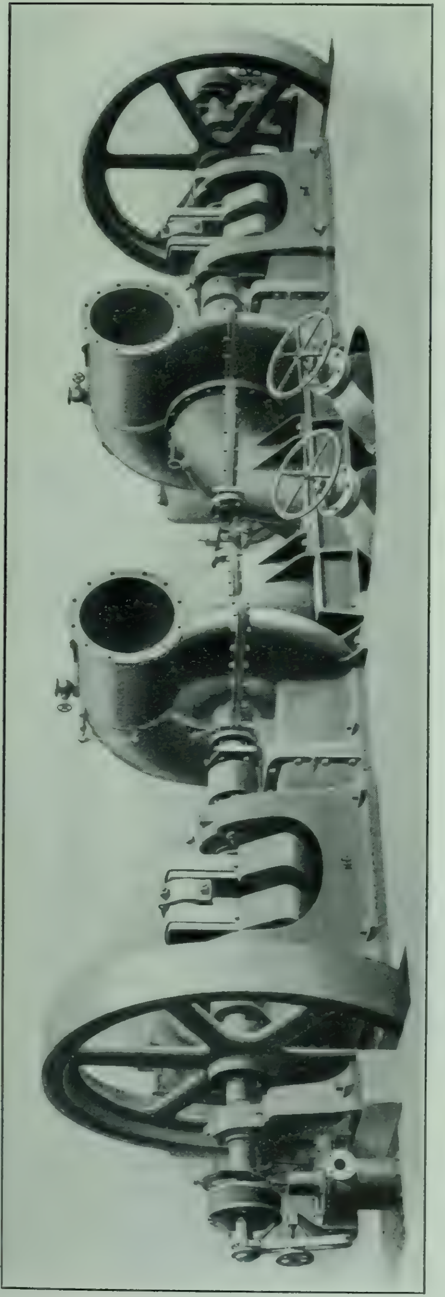


CENTRIFUGAL PUMP DRIVEN BY A DIRECT-CONNECTED VERTICAL ENGINE.

Southwark Foundry & Machine Co.

Until 1900 nearly all dry-dock pumps were steam-driven. Since then most of the new installations have been equipped with electric motors. The pump well must be located at or near the entrance of the dock, in order to make the lengths of the suction and delivery pipes as short as possible, since these are costly to install and greatly increase the friction losses. The engines and piping in a steam plant occupy a great deal more space than do electric motors, thereby increasing the size of the pump house, which area, together with that taken by the boilers and coal bins (which must be installed immediately adjacent) is probably never less than 5,000 square feet. This was the main consideration bringing about the change from steam to electricity, for with the latter the pumps and motors can be located wholly below the coping level of the dock, and the entire area occupied by the steam plant, which is the most valuable in the ship-yard, will be available for the necessary operations involved in the repairs to a ship in dock. The pertinence of this statement is amply verified by reference to the photograph below, showing the pumping plant at the United States Navy Yard, New York, which will be completely abandoned for the underground electric installation to be more fully described subsequently.

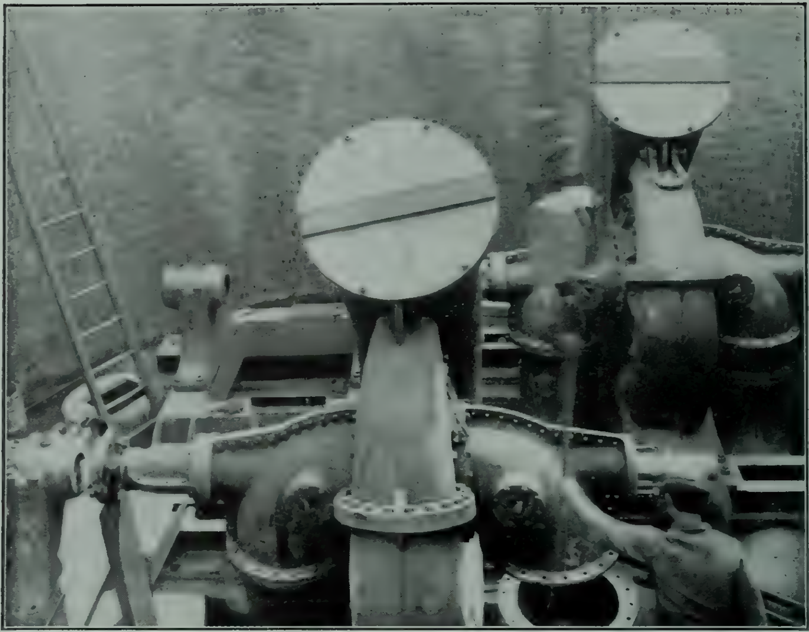
THE STEAM PUMPING PLANT AT THE NEW YORK NAVY YARD. REPLACED BY NEW PLANT DRIVEN BY INDUCTION MOTORS.



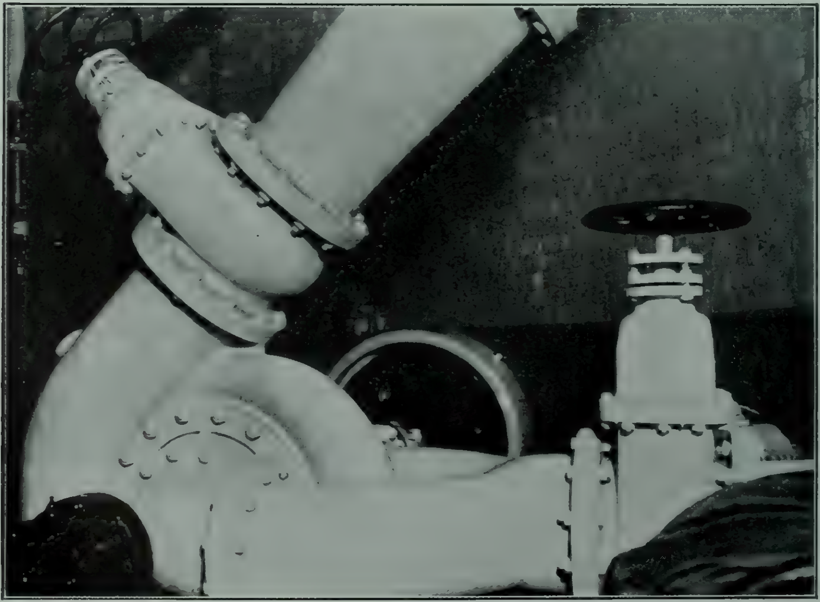
TWO 26-INCH CENTRIFUGAL PUMPS DIRECT-DRIVEN BY 125-HORSE-POWER GAS ENGINES.

Made for the Swansea Harbour Trust by Tangyes, Ltd., Birmingham.

The advisability may be questioned of apparently sacrificing the energy lost in the added operation of generating the electric current; but here there is also economy, instead of waste. The power for operating dry-dock pumping machinery must be always available for immediate use to dock or undock vessels under unforeseen or pressing circumstances. Hence steam must be kept up continuously in either case; but, if the boilers and dynamos are located in the central power house, the power for the pumps can be devoted to other purposes during the times of inactivity, and when pumping out the dock, which requires but two hours, these operations can be temporarily suspended. This use of the dry-dock power for the major part of the time without the expense of initial installation, and other savings incident, are greatly in excess of the value of the energy absorbed by the dynamos and the motors.



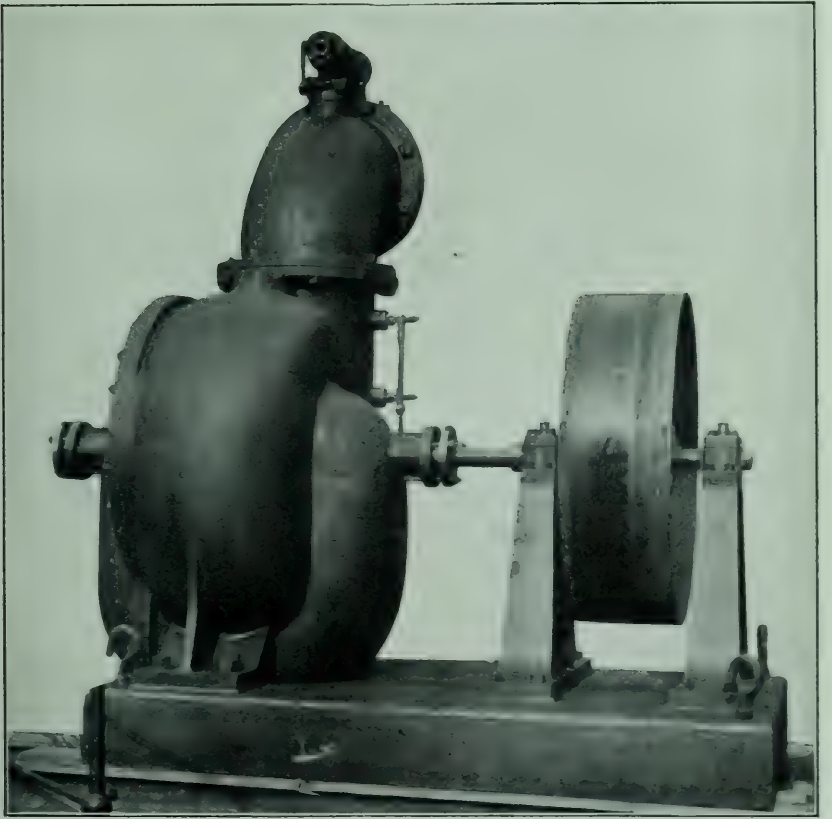
CENTRIFUGAL PUMPS FOR OLD GRANITE DRY DOCK, NEW YORK NAVY YARD; VIEW TAKEN DURING CONSTRUCTION.



CENTRIFUGAL DRY-DOCK PUMP DRIVEN BY A DIRECT-CURRENT MOTOR.

Of necessity the central power plant must be located as near the center of gravity of the loads as may be, and very frequently this makes the lengths of the circuits to the pump wells rather long.

For low-voltage direct current, which is the system in use in commercial ship-yards in America and for naval yards as well in Europe, it has been found that, to provide the necessary copper for the large current transmitted, without undue heating, the area of the conductors must be made very large and this is of course very expensive. It was due to this fact and to the great simplicity of alternating apparatus, that high-voltage alternating current was selected for the motive power for the new pumping plants at the Algiers, Mare Island, Boston, and New York Navy Yards. These installations represent the highest development in dry-dock



ONE OF A NUMBER OF LARGE CENTRIFUGAL PUMPS SUPPLIED TO EGYPT. RAISES 50 TONS OF WATER A MINUTE.

Clayton & Shuttleworth, Lincoln, England.

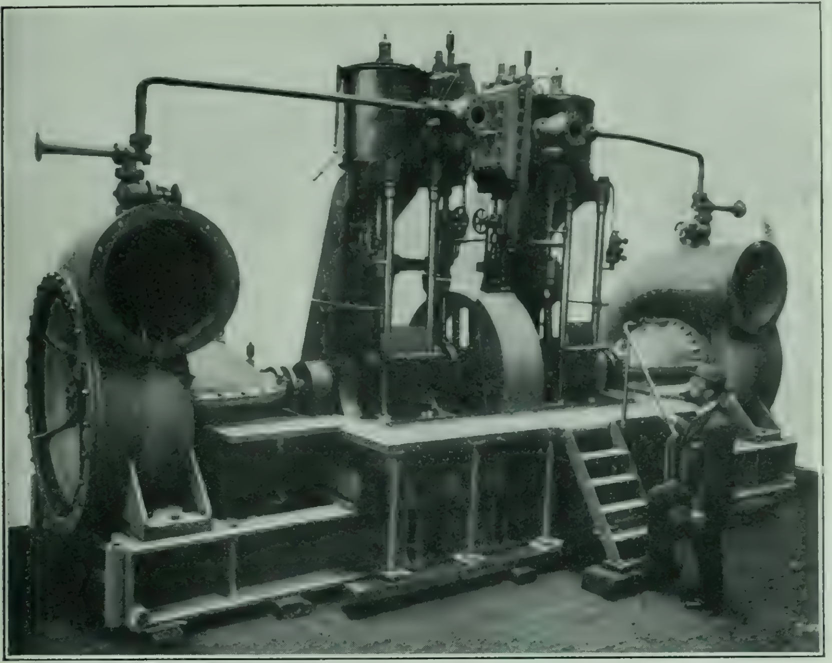
pumping practice, and are but further examples of that progressive spirit that has dominated the American Navy to make it the world's criterion for efficiency and effectiveness.

At the New York Navy Yard the new pumping plant serves to drain two parallel dry docks 350 and 625 feet long, and is located between them in a well 30 feet deep and 45 feet in diameter, which is perfectly water-tight and roofed over with a heavy concrete-steel construction, built level with the dock coping. Three 42-inch, horizontal-shaft, centrifugal pumps of 50,000 gallons each per minute, interconnected to each dock through motor-controlled valves, are the primary units of the plant; while two 16-inch pumps of the same type serve to dispose of any leakage while the docks are empty. The priming of these pumps is accomplished by means of a 10-horse-power motor driving a 12-inch by 12-inch air pump connected to the tops of the volutes. The motive power is furnished by three 415-horse-power induction motors, direct-coupled to the shafts of the large pumps, and each of the smaller pumps is driven by a 125-horse-power motor of the same class. These motors are of the three-phase type and operate on a 60-cycle, 2,000-volt, alternating-current circuit. The large ones have 42 poles each and the small ones 34, and the rotating field is produced by impressing the electromotive force of 2,300 volts on the windings of the stationary part or stator—the secondary part being the rotor connected directly to the pump shaft.

The difficulty with all induction motors—and the determining factor against their universally supplanting the cumbersome direct-current machines—is the fact that their speed can be varied with efficiency through only very narrow limits, greater reduction of their rated speeds being attainable but with little or no diminution in the current actually consumed by the motor and controlling apparatus. Now, in a centrifugal pump, the advantageous velocity varies directly with the head pumped against and is expressed by the formula:—

$$u = \frac{a \; g \; H}{Q}$$

in which u is the velocity of the outer circumference of the impeller; a, the area of the discharge pipe; H, the actual head plus the friction head; Q, the discharge, and g, the acceleration due to gravity. It would seem, therefore, since the speed of the above motors cannot be economically reduced, that this type is not desirable for dock pumps. But the conditions peculiar to the work of dry docks alter this. When a vessel is to be docked, the water must be removed with the least possible delay; for even a slight loss of time in the docking of one of the



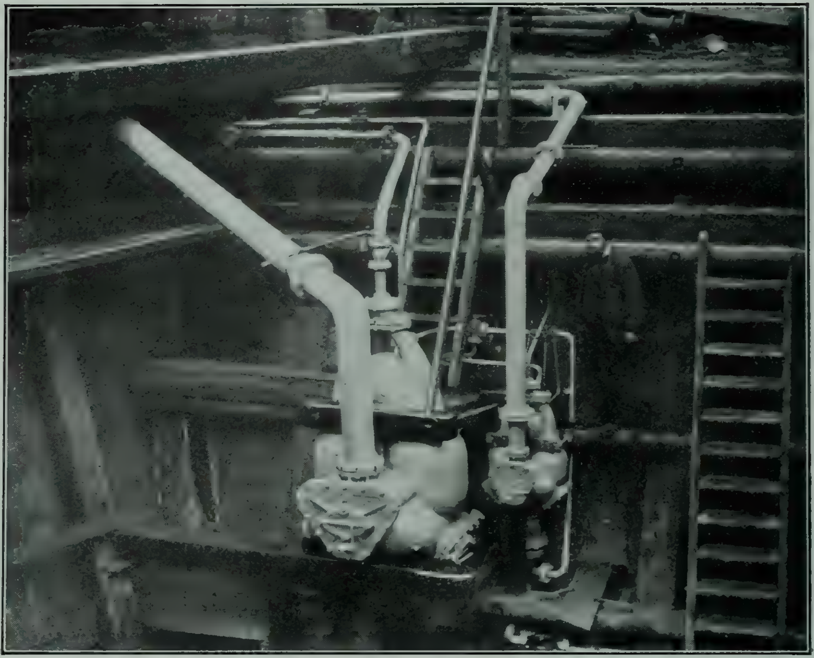
PAIR OF 21 BY 18-INCH ENGINES AND 30-INCH CENTRIFUGAL PUMPS, FOR A DOCK AT NAGASAKI, JAPAN.

Supplied to Stockton & Co. by Tangyes, Ltd., Birmingham.

giant transatlantic cruisers might result in its total loss, together with the immense capital invested, and of what vital importance would every moment be withdrawing one of our battleships from a defending squadron in case of war!

The pumps and motors were therefore designed for a rated speed corresponding to a head of 17 feet, within which head is included three-fourths of the entire amount of water in the docks. The pumps are started and maintained at this velocity, thereby obtaining a greater discharge during the first part of the pumping down to 17 feet (which is the major part) and the efficiency lost in the increased discharge is far less than that lost in attempting to control the speed—and in addition, there is the actual money value of the ultimate saving of time resulting.

The current for these motors is supplied by means of a turbo-alternating unit of the three-phase, 60-cycle type, designed to run at 1,800 revolutions per minute and at a primary voltage of 2,300 volts. It is capable of running continuously at 50 per cent. overload for two hours



TWO PULSOMETERS WORKING IN A DRY DOCK IN THE NORTH OF ENGLAND.

without injurious mechanical or electrical strain, and with a temperature rise of not more than 60 degrees C. above that of the surrounding atmosphere. It can also be momentarily overloaded 100 per cent. without harmful effects. At full load this unit consumes 20.5 pounds of dry steam per kilowatt hour, if operated condensing with 2 inches of absolute back pressure in the condenser.

The distance between the generator and the pumpwell is 1,350 feet, and in the circuits supplying this alternating current an actual saving of $31,000 is made above the cost of the conductors required for transmitting the requisite amount of direct current.

Though differing slightly in details from the above, the plants at Algiers, Mare Island and Boston are similar in principle; and, when all are completed, the dry-dock pumping equipment at these yards will be such as to afford the readiest and most efficient means for repairs, thereby adding untold strength and effectiveness to the vessels of the navy dependent upon them.

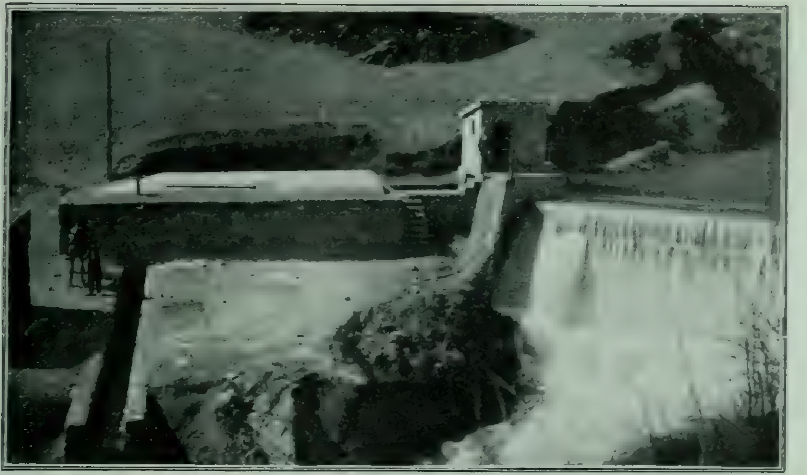


FIG. I. THE DAM AND INTAKE.

A GRAVITY CEMENT MILL IN THE PYRENEES.

By Geo. M. Peek.

Mr. Peek's article (like that by Mr. Burns, which directly follows it) is particularly interesting in that it shows how the resources of countries which are in their industrial infancy are being developed by the engineering talent and the machinery builders of the more progressive nations. Mr. Peek, like Mr. Burns, was in direct charge of the work he describes.—The Editors.

THE Compañia General de Asfaltos y Portland was organized in Barcelona in 1901, for the purpose of acquiring and developing mines, quarries, and water power. In the Province of Cataluña near the little village of Pobla de Lillet, about one hundred and thirty-six kilometers from Barcelona, the company encountered an abundance of cement, or argillaceous rock, limestone, gypsum, and coal, being all the ingredients required for the manufacture of Portland cement. In addition to this, they found that the Llobregat River, which runs by the stone quarries, would give them an effective head of about one thousand feet and ample water for the development of sufficient power for turning out 1,000 barrels of cement per day.

After making a careful investigation of machinery manufactured in the different countries of Europe and the United States, they concluded that the best place in which to buy such machinery was the United States, and consequently the order for the machinery for the complete plant was placed there. The location of the quarries was such that the company could build what might be called a gravity cement mill, and save the expense and power otherwise needed for elevators.

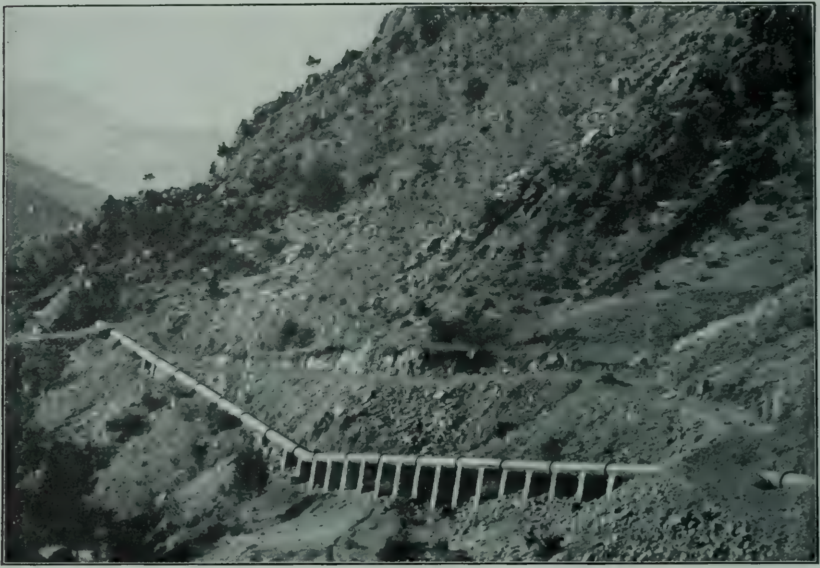


FIG. 2. THE PIPE LINE ENTERING THE TUNNEL.

I was sent over to Spain to make the survey and locate the pipe line. The source of the Llobregat River is a large spring, in the foot hills of the Pyrenees Mountains, which has a flow of 300 to 1,200 litres of water per second. Just below this spring it was decided to build the dam and intake for the pipe line. Figure 1 shows the dam and intake, with gates and gate-keeper's room and telephone station. From the level of the dam to the lowest level in the mill there is a fall of 1,049 feet. The pipe line from the intake to the last section in the mill is 14,935 feet long and, as far as I am able to ascertain, is the longest steel power-pipe line in the world. It is riveted steel, made up in sections 20 feet long, fitted with pressed-steel flanges, and bolted together with round rubber gaskets between the flanges. The plates of which the pipe is made vary in thickness from 10 B. W. G. at the intake to 9/16 inch at the mill. The main line is made in three diameters. From the intake one-third of the way down, the pipe is 31 inches in diameter; the middle third is 28 inches in diameter, and the last third is 26 inches in diameter. The lower part of the pipe in the mill is 18 inches in diameter and made of 7/16-inch steel plate.

When the pipe line was completed the water was gradually turned in, about ten days being taken for this work, in order that the flanges

FIGS. 3 AND 4. TWO OF THE BRIDGES ON THE PIPE LINE.

might be tightened up where necessary. When finally filled the head gate was closed, and after a lapse of 24 hours it was found that there was no drop whatever in the pressure; this, considering the length of the line, is somewhat remarkable. The wheel connections are made of cast iron and lap-welded tubing.

Figure 2 shows the line at a point where the pipe enters a tunnel. As the country is exceedingly rough and rocky, it was necessary to make the pipe with a great many bends in it. A plan and profile of the pipe was made and sent to Spain for the contractors to do the grading, and to build piers, bridges, and tunnel. There are five bridges, and one tunnel through solid stone.

Figure 3 shows bridge No. 5, which has a grade of 34 per cent. Figure 4 shows bridge No. 3, which has a grade of 18 per cent. Figure 5 shows a pipe-locating gang.

The nearest railroad station is Ripoll, some 35 kilometers from the mill, and all of the pipe line had to be hauled on carros by mules to the mill, and from the mill on specially constructed trucks to places near the line, and finally let down in place by means of capstans or winches. Figure 7 shows a part of the road which was built for hauling the machinery to the mill, and which will be used for transporting the cement. At present cement will be hauled to Hostelnou, which is about 7½ miles from the mill, by means of a locomobile and wagons. The railroad was built from Olvan to Hostelnou after the machinery was hauled to the mill.

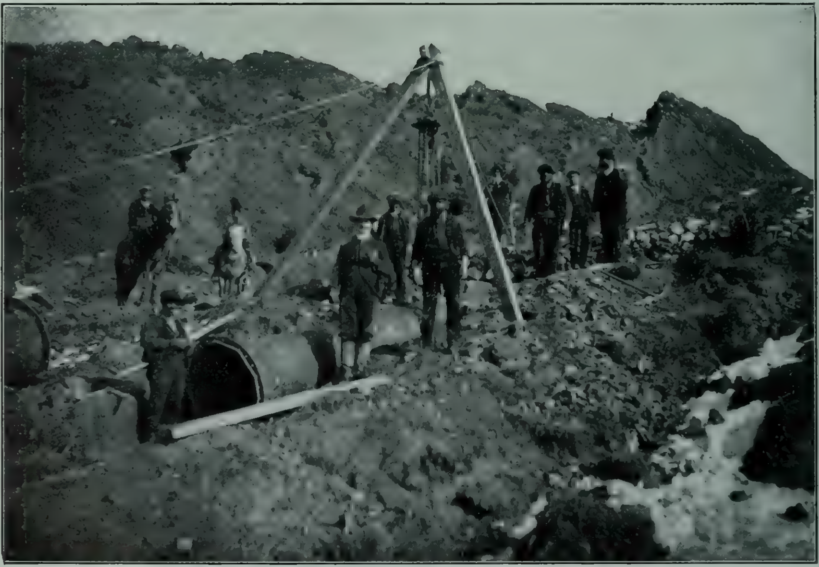
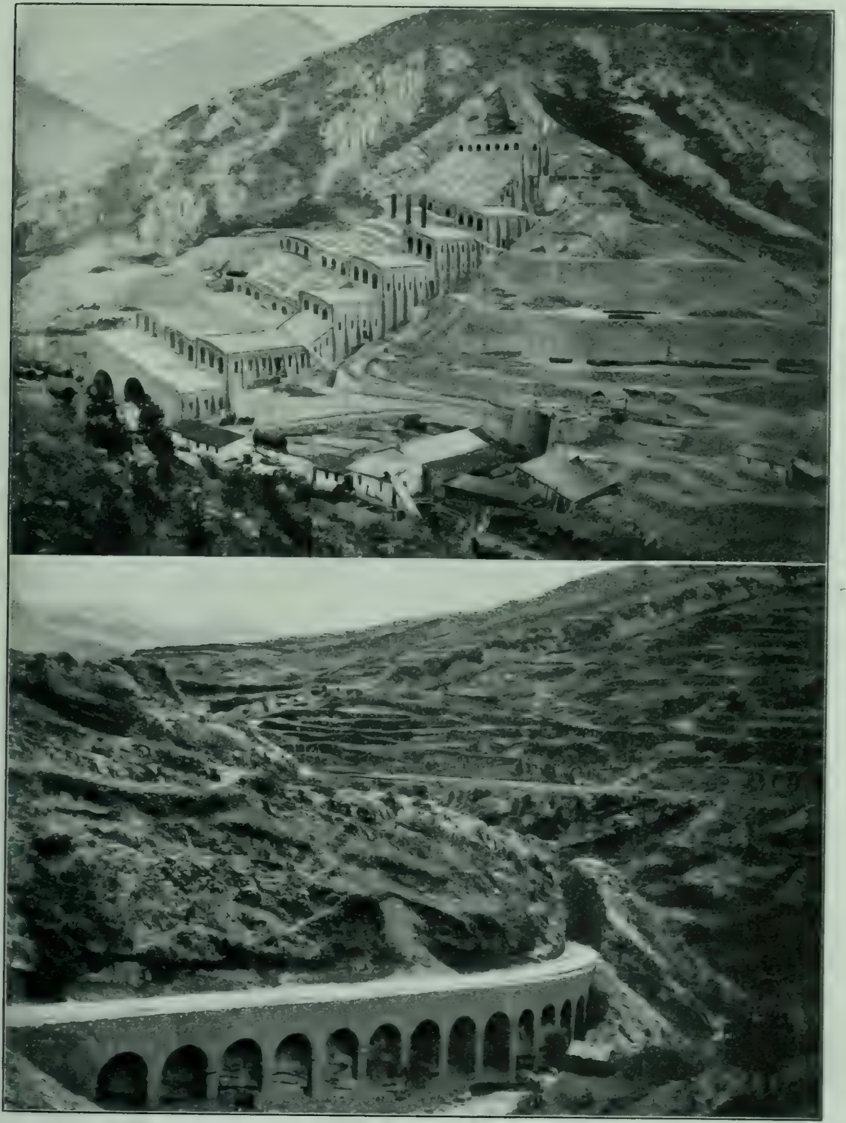


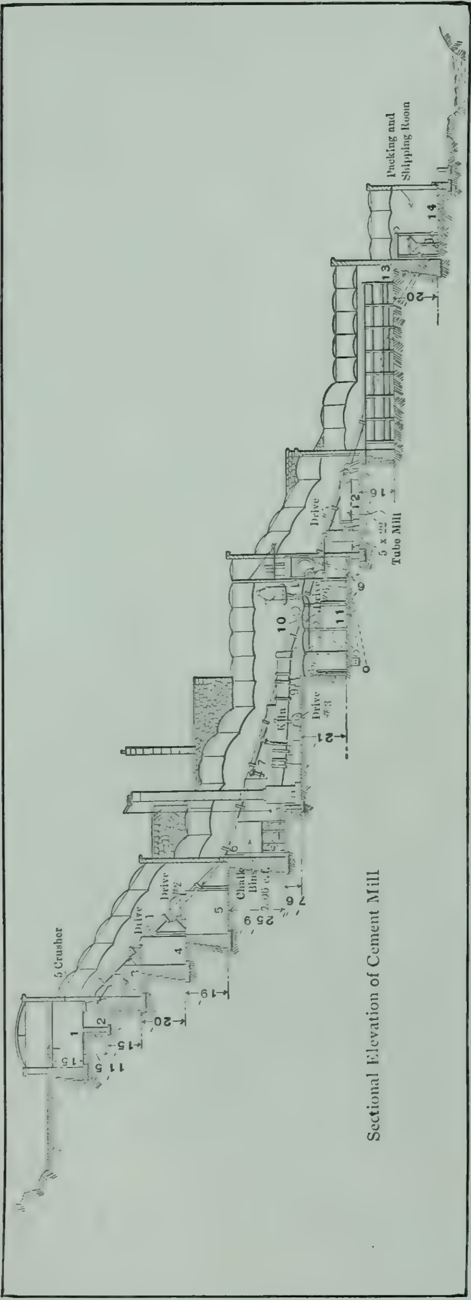
FIG. 5. A PIPE LOCATING GANG.

The pipe enters the mill on level No. 1, which is the storage room for the stone as it comes from the quarries. The cement stone (or argillaceous stone) quarry is located at the back of the mill and a little above level No. 1. The stone is hauled in wheel-barrows and dumped



FIGS. 6 AND 7. THE MILL, AND A PART OF THE ROAD LEADING TO IT.

into this storage room. The limestone quarry is located some 500 yards away from the mill, and the quarried stone is hauled in tram-cars by gravity to the storage room, the cars being hauled back by mules. The coal mine is located some two or three miles away. At present the coal is brought down the mountain to the road by means of pack mules; here it is loaded into the locomobile wagons and hauled

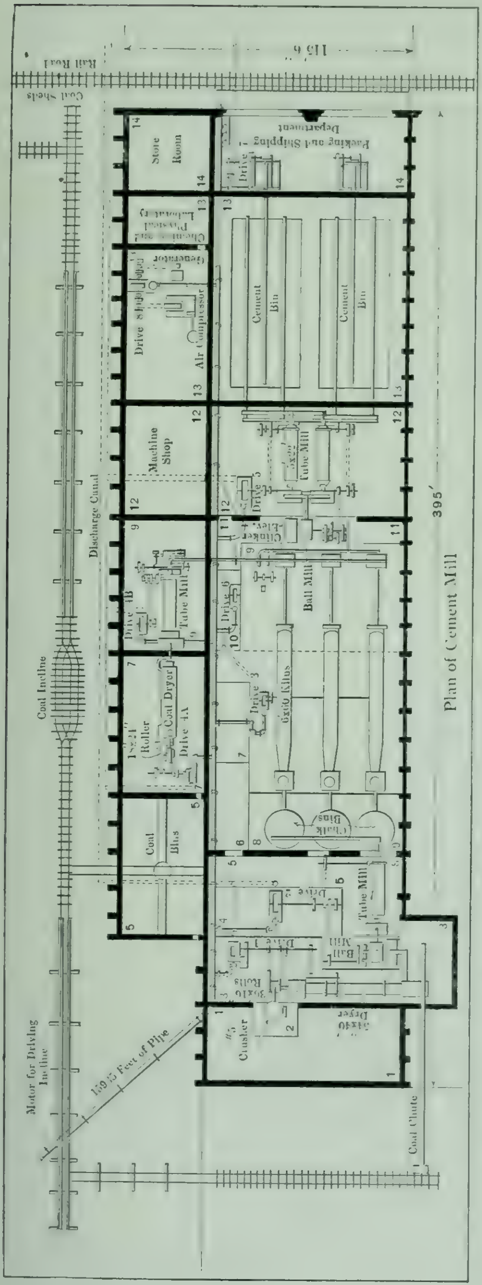


Sectional Elevation of Cement Mill

to the foot of the mill, and is elevated to the top of the mill by means of an inclined railroad.

Figure 6 is a photograph of the mill, taken from the opposite side of the river. As will be seen from this, the photograph was taken before the stacks for the stone dryer and coal dryer were located. On this page is shown a sectional elevation of the mill, and on the opposite page a general plan of it. As will be seen from the plan, only one-half of the mill has been erected. The complete mill is to have six kilns and a capacity of one thousand barrels of cement per day. All the excavations for the second half have been completed, and the company expect to complete the whole mill in the near future.

On level No. 2 is located a gyratory rock crusher into which the weighed stone is thrown and from which the stone passes to a pair of crushing rolls. It then passes to the stone dryer on level No. 3. Figure 10 is a photograph showing the crusher, crushing rolls, and stone dryer. This constitutes what is called drive No. 1, the entire power installation being divided in-



to some ten "drives," corresponding to the various sections of the mill, each independently driven by a Pelton wheel of power adapted to the work required. No. 1 is driven by a 48-inch double-nozzle wheel, which has a maximum capacity of 220 horse power at 450 revolutions. Figure 11 is a photograph showing the wheel for drive No. 1. From the stone dryer the stone passes to a ball mill on level No. 4, and thence to a tube mill on level No. 5. The ball and tube mill constitute what is called drive No. 2, which is driven by an 88-inch double-nozzle wheel, having a maximum capacity of 350 horse power at 300 revolutions. From the tube mill the stone is conveyed by means of screw conveyors to the storage bins ready for the kilns. Figure 14 shows the kilns.

The coal mill is located at the side of the cement mill, being separated from it by a two-foot stone wall. The coal-storage room is located on level No. 5, where the coal is delivered to it from the inclined railroad. From this room the coal is conveyed to a pair of crushing rolls, from which it is delivered to the

FIGS. 10 AND 11. THE CRUSHER, CRUSHING ROLLS, AND STONE DRYER, AND THE 220-HORSE-POWER PELTON WHEEL DRIVING THIS MACHINERY.

The cement machinery was supplied by the Allis-Chalmers Co., general contractors for the installation.

rotary dryer. The rolls and dryer constitute drive No. 4-A, driven by a 48-inch single-nozzle wheel, which has a maximum capacity of 70 horse power at 560 revolutions. From the dryer the coal passes to the tube-mill hopper, from whence it is conveyed to the tube mill.

After the coal passes through the tube mill, it is elevated and conveyed across, by means of a screw conveyor, to the coal hoppers at the ends of the kilns. This constitutes drive No. 4-B, driven by a 60-inch double-nozzle wheel, which has a maximum capacity of 220 horse power at 450 revolutions.

In the present kiln room are three 60-foot by 6-foot kilns, driven by a 48-inch single-nozzle Pelton wheel, which has a maximum capacity of 70 horse power at 560 revolutions. The kilns are located on level No. 9. Just below the kilns, on level No. 11, are located the coolers, one for each kiln. These coolers are supplied with air from a rotary blower. This blower, together with the blower for feeding the coal into the kilns, and the clinker elevator, constitutes drive No. 6, driven by a 66-inch single-nozzle wheel, which has a maximum capacity of 80 horse power at 400 revolutions. It may be noted here that the cool air enters the coolers at the bottom, passes up, and is drawn from the top of the coolers by the fan which blows the coal into the kilns. By this means, the coal is fed into the kilns mixed with hot air. The clinker falls from the coolers onto a belt conveyor and is conveyed to the clinker elevator. At this point the required amount of gypsum is added, for the purpose of regulating the time of setting of the cement. The clinker ball mill and finishing tube mills constitute drive No. 5, driven by a 91-inch double-nozzle wheel,

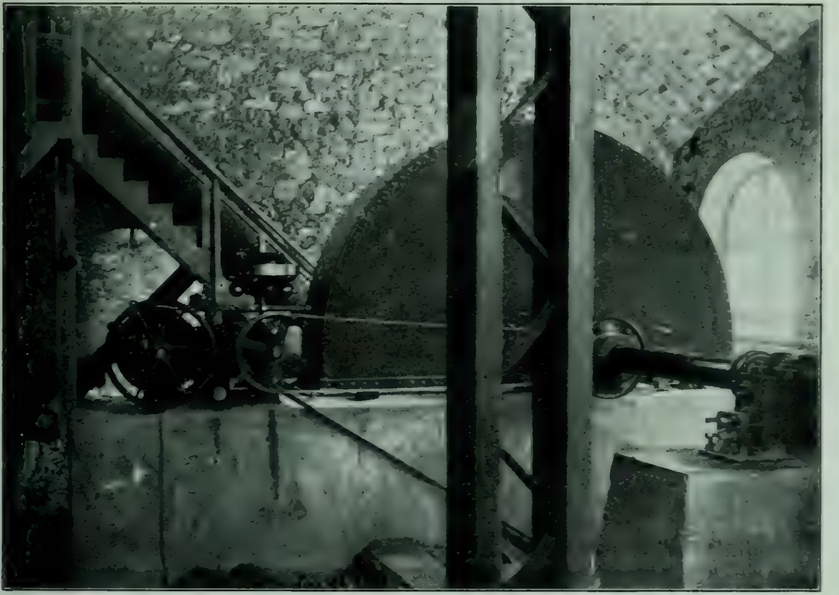


FIG. 12. 350-HORSE-POWER PELTON WHEEL, DRIVE NO. 2—THE BALL AND TUBE MILL.
88-inch, double-nozzle; 350 horse power at at 300 revolutions.

having a maximum capacity of 550 horse power at 300 revolutions. From the finishing tube mills, the cement is conveyed by means of screw conveyors to the stock-room bins, which have a capacity of 20,000 barrels. The stock room is located on level No. 13.

On level No. 14, twenty feet below No. 13, is located the packing machinery, driven by a 24-inch motor, with a maximum capacity of 35 horse power at 1,160 revolutions, being drive No. 7.

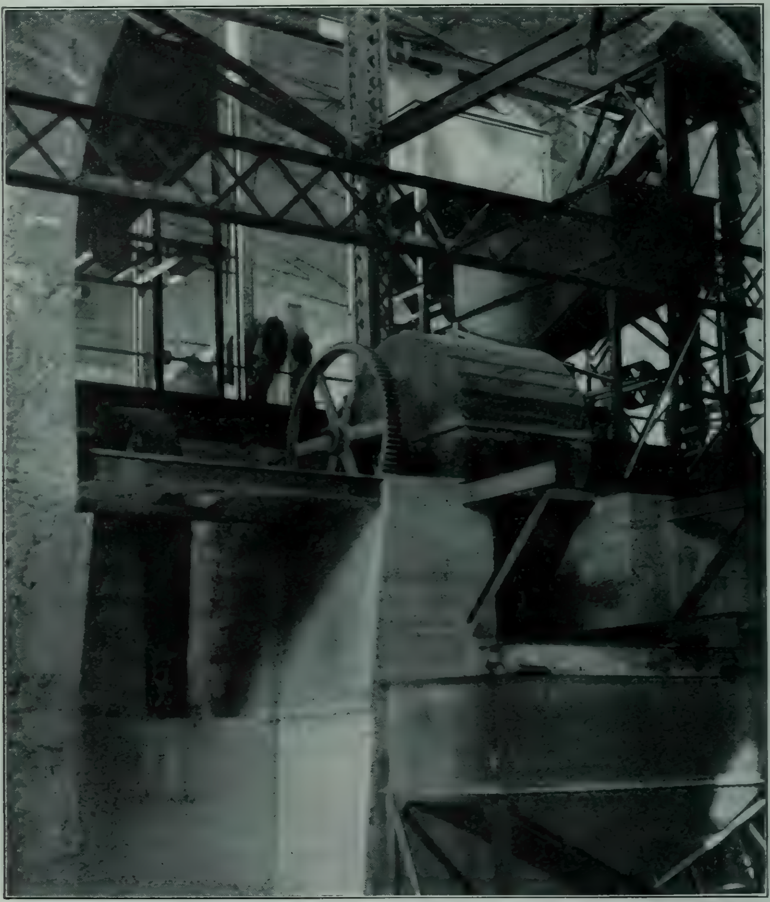


FIG. 13. THE FINISHING BALL MILL.

On level No. 12 in the coal mill is located the machine shop, fitted out with all necessary machines for making repairs. On level No. 13 of the coal mill is located an 85-kilowatt direct-current compound-wound generator, for lighting the mill and office buildings; also a 22¼ by 14¼ by 16-inch duplex air compressor, capable of driving eight 3-inch cylinder drills at 1,000 feet above sea level. The gen-

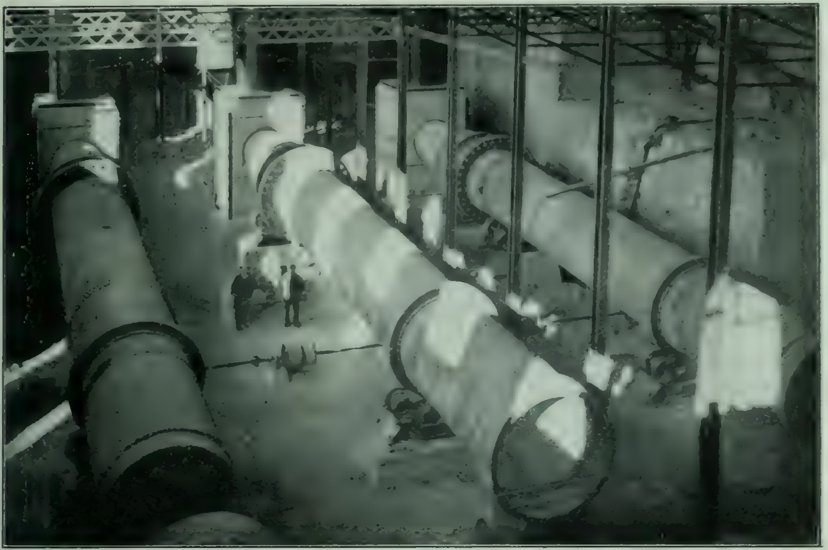


FIG. 14. THE KILN ROOM.

erator and compressor are driven by a 60-inch double-nozzle wheel, having a maximum capacity of 350 horse power at 450 revolutions. This constitutes drive No. 8. Figure 15 is a photograph of this drive. Adjoining the dynamo room is the chemical and physical laboratory.

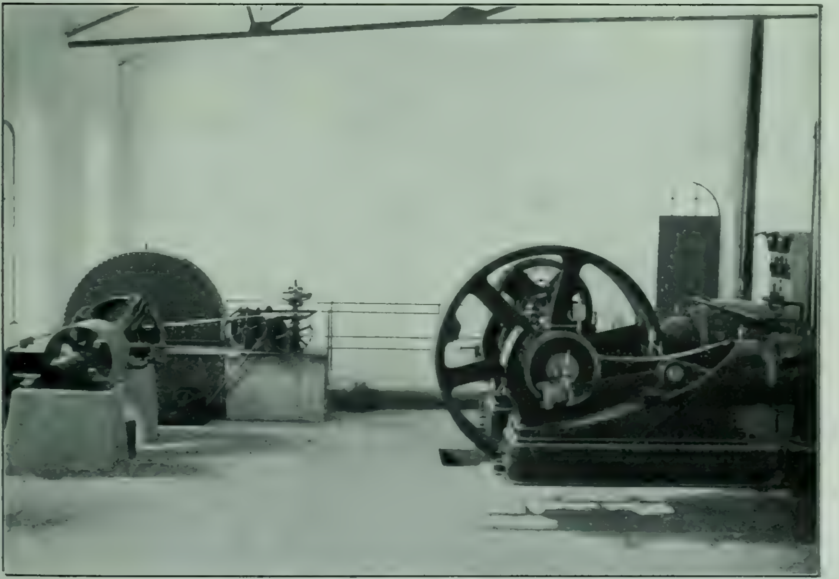


FIG. 15. THE DYNAMO ROOM AND 22¼ BY 14¼ BY 16-INCH INGERSOLL-SERGEANT AIR COMPRESSOR.

THE OFFICIAL TRAIN AT THE FAT SHAN OPENING OF THE CANTON-HANKOW RAILWAY.

THE ACTUAL BUILDING OF A CHINESE RAILWAY.

By Justin Burns.

In a preceding article, in our issue for November, Mr. Burns reviewed the general preliminaries to the construction of the Canton-Hankow railway line, in the middle south of China. He described—from the standpoint of the engineer in charge of construction—the official negotiations, the process of acquiring the right of way, the character of the country traversed, the organization and maintenance of the engineering corps, and the methods of conducting the field work under the peculiar conditions occasioned by the country and the people. In the following pages he takes up the actual work of building and operating the line, as exemplified by the first division opened.—The Editors.

CONSTRUCTION was begun on the Sam Shui division of the Canton-Hankow line before starting the main line to the north. This division extends westward from Canton through the delta to the West, North, and Pearl rivers, and traverses rice fields for the entire distance with the exception of some abrupt irregular hills toward the western end. This delta country is flat and intersected with numerous navigable tidal diked streams, of which those crossed by the railroad rarely exceeded 100 feet in width. At Canton the dikes varied in height from 4 to 8 feet, but near the western end of the division dikes 30 feet in height were required to afford protection from the flood waters. The grade for the first half of the division was so laid as to be slightly above extreme high water, but toward the Sam Shui end, wherever there were strong efficient dikes, these embankments were depended upon to protect the line from inundation. At the important streams the grade was raised to cross these rivers at a height sufficient to allow the passage of the hull of the larger cargo junks, since it was customary in Chinese bridge construction to inflict the inconvenience upon the boatmen of taking down their sails and masts in order to pass these structures. Against this hardship, the patient Chinese made no vigorous protests.

No trouble was experienced in finding Chinese eager to enter into contracts for constructing the earthwork or bridge masonry. In Hongkong there were many Chinese firms fully competent to manage and execute important and extensive construction work in the line of buildings. The erection of these large commercial structures had been superintended for years by European engineers, with the result that many Chinese artisans had been so educated in the work as to become proficient in successfully undertaking construction of a similar character. Consequently, with the railroad work, the suc-

AN EARTHWORK CONTRACTOR WITH HIS MANDARIN BACKERS.

The mandarin in the light-colored garments is a multimillionaire, his fortune having been amassed in the spice trade in Singapore. He had served as a director in the Chinese railways and proved himself an able and far-seeing business man.

cessful bidders were Chinese builders, mainly from Hongkong; but through ignorance of railroad requirements and this different class of construction, these contractors unfortunately bonded themselves to perform work at too low a figure to make money. If the earthwork could have been commenced when contemplated, at the openings of the bids, in the early winter, the low rate of six cents silver (two and a half cents gold) per cubic yard would have been sufficient for the contractors to make a profit, because the earth could be handled in the cool, rainless months of winter when the coolies were free from farm work, and when an inexhaustible supply of labor could have been obtained at a low figure. Unfortunately, the wheels of the local government moved so slowly that it was nearly spring before the proclamation was issued to permit the breaking of ground, and the unlucky contractors commenced their work at the beginning of the rainy season.

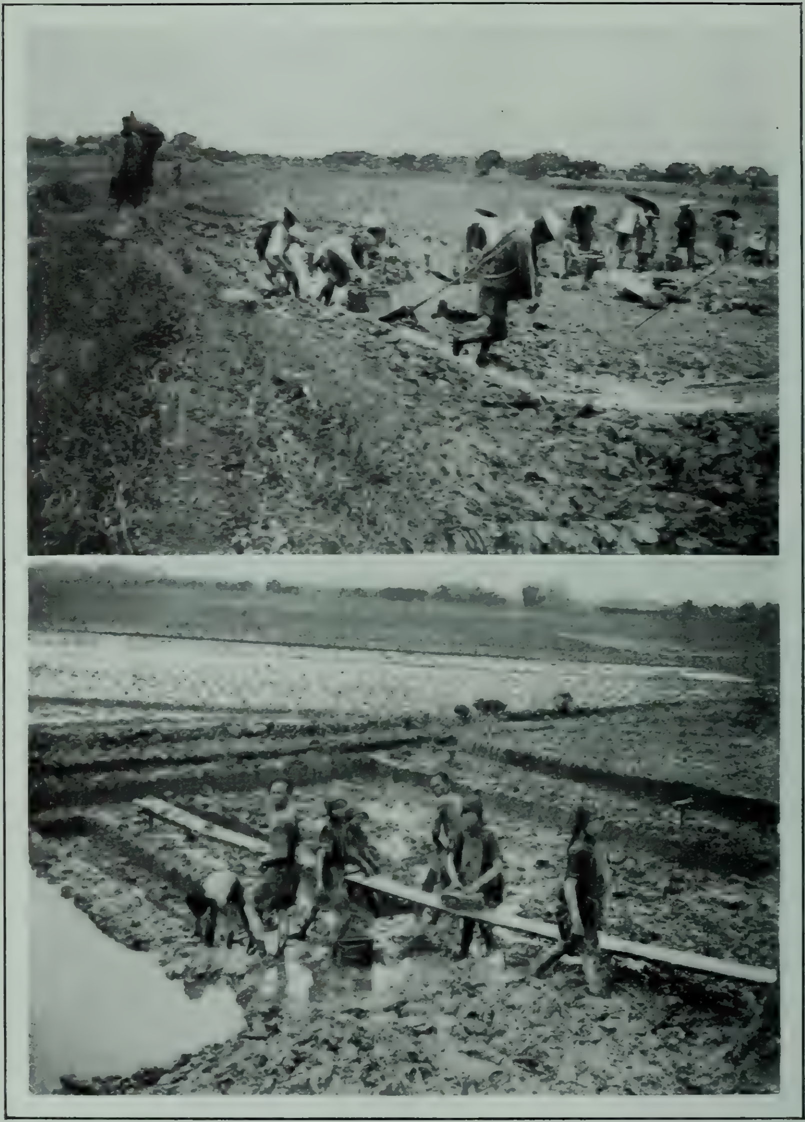
These Chinese practically completed their embankment contracts, but it was necessary to take the bridge work out of their hands and complete these structures under foreign foremen supervising native labor. In the case of the embankments, it was not difficult to obtain coolies who had been skilled in the handling of clay in constructing and repairing the innumerable dikes which filled the country. With these Orientals the element of time never seemed to be thoroughly understood, and, generally speaking, no contractor ever paid any regard to the completion of his work at the time promised. Their training and education could find no reason for the impatient urging of the foreign engineer, who used all means known to both civilizations to impress upon the Oriental mind the importance of the obligation of finishing within a limited period.

Much has been written in praise of the Chinese characteristic of faithfully fulfilling a contract or business obligation in the spirit and letter of the agreement, even though there were no written evidence of a promise, and even though the transaction would involve pecuniary loss to the Oriental. It is to be regretted that this railway work in South China cannot substantiate this much quoted and praised characteristic. It may have been that the Chinese builders were reared in a different school of business ethics from the merchants; the railroad contractors were certainly thoroughly grounded in the fine arts of equivocation and scientific dishonesty of action and intent.

"Squeezing," or the retaining of a certain percentage of money which passes through his hands in the payment for labor or materials, is rated by the Chinese as one of the perquisites of his position; the severe measures visited upon the detected offenders rarely convinced the Oriental mind that the foreigner wanted absolute honesty. But the practice of this extortion of money penetrates all classes of Chinese, from the lowest head coolie to the highest throne official, and it forms one of the ineradicable evils which has to be diplomatically handled to construct successfully in Chinese territory. If the poor coolie can be justly treated, and taught to realize that the railroad enterprise will bring full value for his labors, it will be difficult for the opponents to the introduction of foreign ideas to present effective arguments counteracting this material prosperity, which would arise from the additional employment and money given to the thousands of families by reason of this new work. The ill-treatment of the laboring classes in the construction of the railroads in the northern parts of the Empire has often been asserted to be the indirect cause of the uprising of the natives against foreigners in 1900.

CONTRACTORS' COOLIE SHACKS CONSTRUCTED OF PALM LEAVES AND BAMBOO POLES. A kitchen is seen in the foreground with the temporary clay fire places and the kettles for rice.

In order to hasten the construction of the Sam Shui division, some of the work done in the high embankments and deep cuttings was performed by day labor under the supervision of foreign foremen; but this work proved costly. The results deduced from the various methods of conducting work indicate that the greatest economy in the cost of construction can be obtained by letting small sections of the work to innumerable petty contractors, without the intermediation of



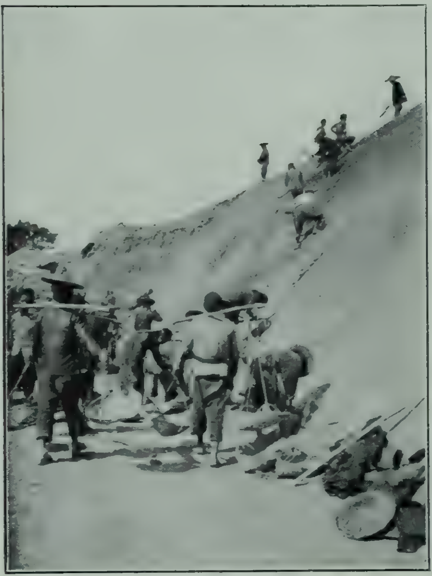
EXCAVATIONS IN SOFT EARTH. THE UPPER VIEW ILLUSTRATES THE USE OF SLEDS IN TRANSFERRING CLAY BLOCKS TO THE EMBANKMENT. THE LOWER ONE SHOWS WOMEN IN THE BORROW PITS, SLIDING BLOCKS OF CLAY ALONG BOARDS.

general or supervising native managers. This removes an opportunity for squeezing, and affords a greater probability that the coolie will receive his full pay. The small contractor is often co-operative with his laborers; when the native is working so that his greater individual effort brings him greater gain, his efficiency is increased to many fold that developed under hire at a daily stipend.

The first contracts of five-mile sections were sublet by the Chinese contractors to various lesser contractors, who were generally the heads of families or communities; these sub-contracts for three or four hundred feet of embankment were taken at a certain unit rate which was sufficiently low for the general contractor to realize some profit from the work. The sub-contractor utilized all members of his community or family to fulfil his contract, and often not only men, but women and children, filled the borrow pits. It was a common sight to see gangs of laborers composed entirely of women, many of whom worked with their infants strapped to their backs. It might be interesting to state that the women coolies formed more efficient and less troublesome earth laborers than the men. The inciters of strikes and labor riots seemed to have less effect upon these unfortunates.

BLOCKING OUT THE CLAY WITH THE TWO-HANDED SPADE AND TOSSING THE BLOCKS TO THE EMBANKMENT.

The rice fields are of dark blue clay, which overlies the rock to a depth varying in this delta country from 20 to 50 feet. Where the ground was moist and the clay tenacious, the material in the borrow pits was cut by spades into blocks each containing about a quarter of a cubic foot. These blocks were transferred to the embankments in various manners which depended upon the ingenuity or desire of the

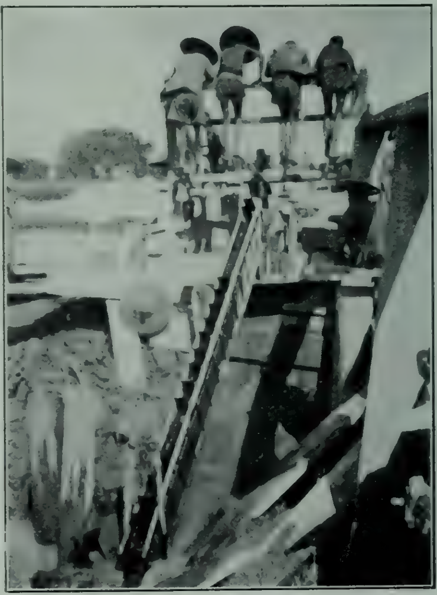


"SANDPAPERING" THE CUTS.

sub-contractors. On the low embankments it was usual to place coolies in rows extending from the borrow pits to the embankments, and to toss the blocks of clay from hand to hand until placed in the construction. Another method which proved economical was to lay planks from the borrow pits, and by posting workmen along these boards at short intervals the blocks of clay were slid on the wetted planks until finally placed in position in the fill. Then, again, sleds, drawn by the coolies over roadways of wetted clay, were used to transfer large loads of blocks to the embankment.

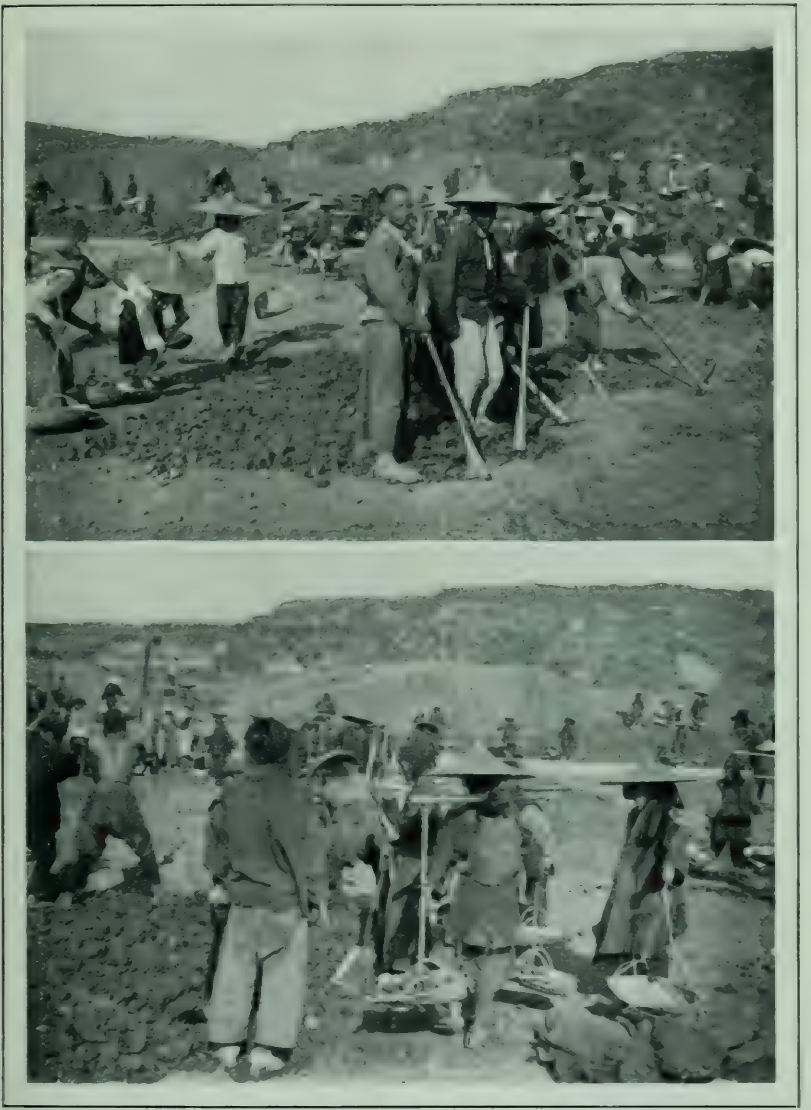
Where the clay contained a certain percentage of sand, the blocks did not retain their form sufficiently to permit tossing or sliding, and in these cases baskets suspended at the ends of bamboo shoulder poles were in general use.

In all the high embankments and hill cuttings the transportation of material in baskets was the only method employed. The attempt was made to use wheel-barrows, but this was economically a failure either through the inability or the unwillingness of the Chinese to utilize this innovation. Although wheel-barrows are used to great extent in other portions



CHINESE WOODEN CHAIN PUMPS, OPERATED BY A TREADMILL.

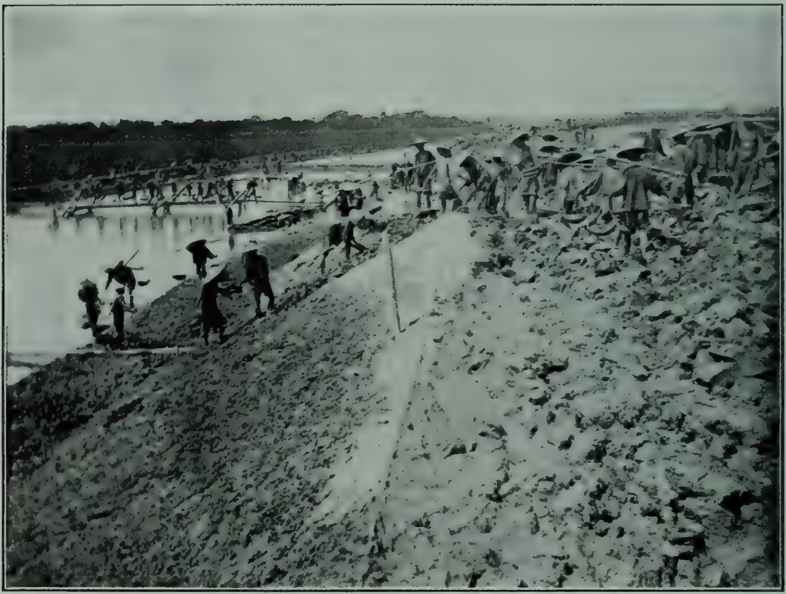
These pumps were used for removing the water from the coffer-dams, and for a low lift they are very efficient.



EXCAVATIONS IN HARD EARTH, SHOWING WOMEN COOLIES CARRYING BASKETS OF CLAY; THE ONE IN THE FOREGROUND OF THE LOWER PICTURE HAS HER INFANT STRAPPED TO HER BACK.

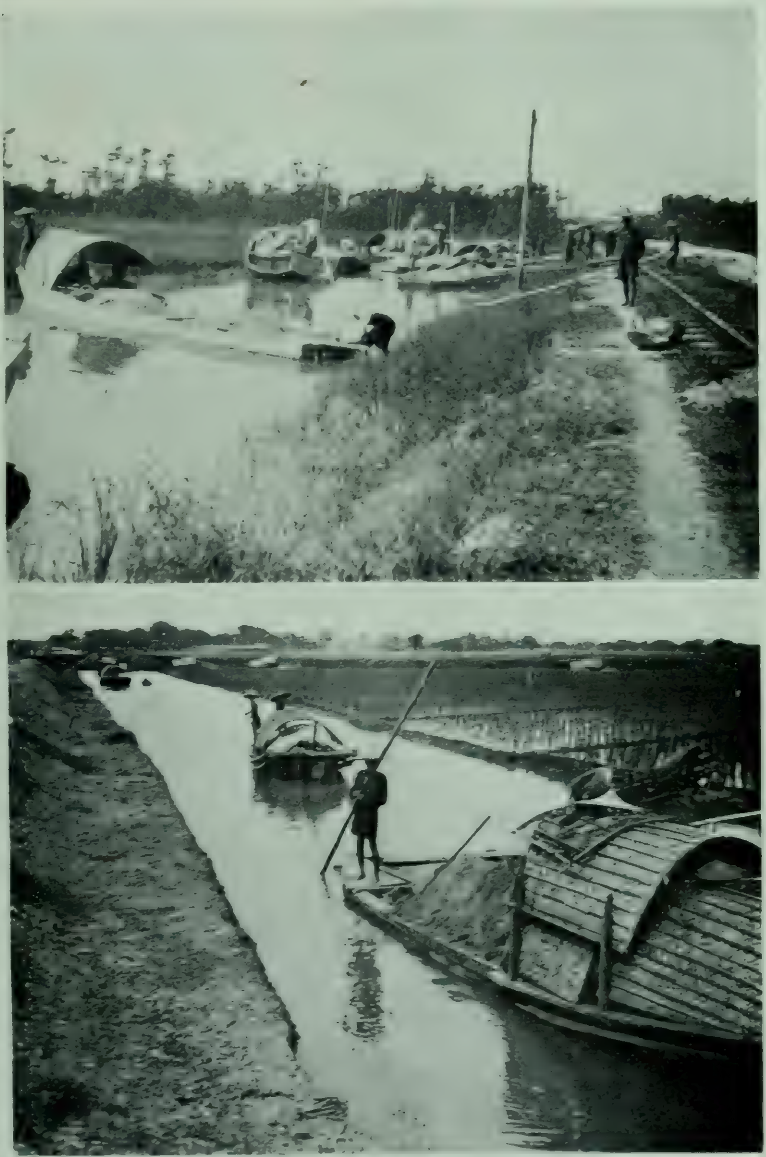
of China, they are little known in South China, and therefore the coolies seem to make best progress with the methods in handling dirt which had been familiar to their predecessors. There are no horses or carts in this roadless country, and so their economical employment could not be made use of in the dry hill cuttings. Occasionally a little plowing was done by the water buffalo or carabao, and with this rare exception all of the earth work was done by hand labor.

In the rice fields and low ground the tools used were both long handled and short two-handed wooden, metal-tipped spades which blocked out the clay. In the dry earth and in the hill cuttings the coolies used a heavy metal-tipped wooden hoe to cut out the earth and drag it into the baskets. When the clay was hard and compact, foreign picks and shovels were used. The excavation in hard earth was a new feature to the coolies who had few native tools suitable for this work.

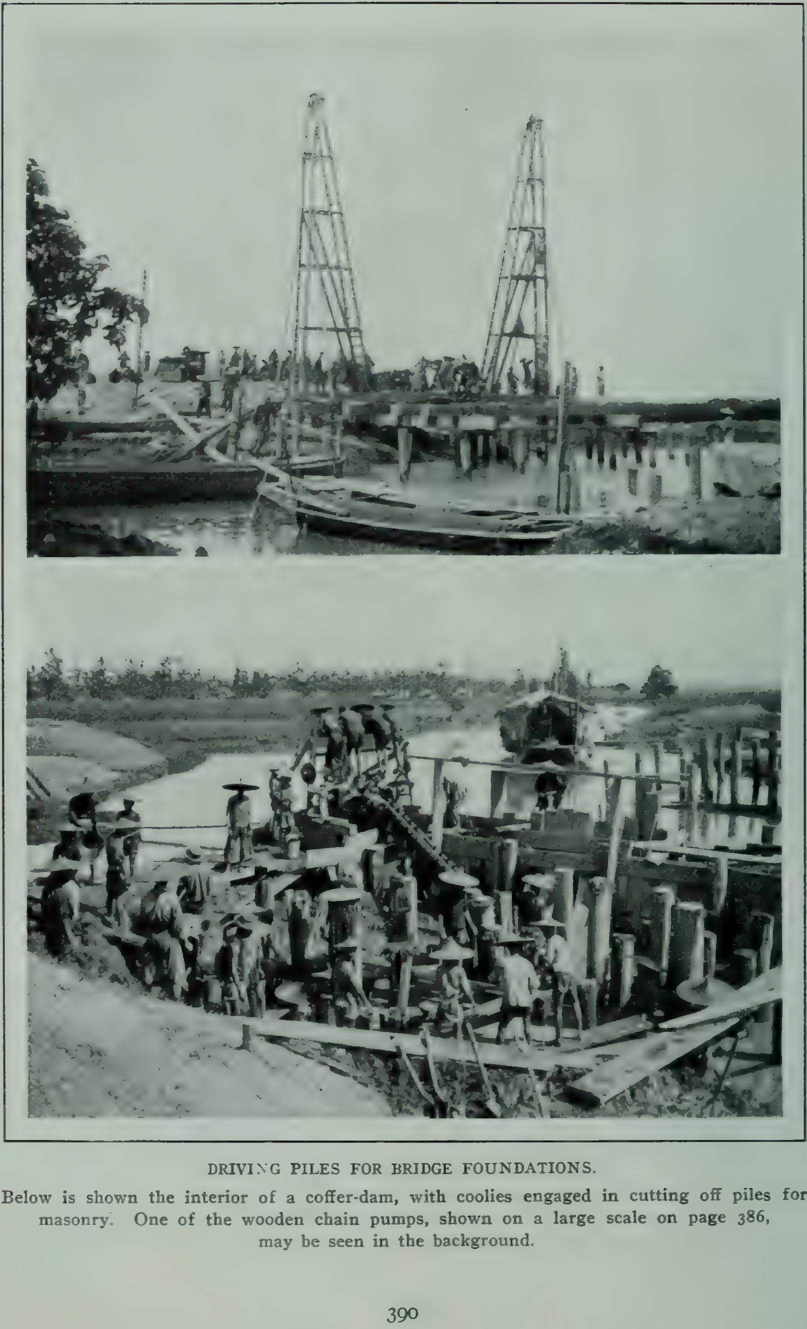


FINISHING SOME OF THE HIGHER EMBANKMENTS.

During the construction of the embankments, care was taken that the borrow pits from which the earth was removed should be excavated in a definite regular manner. At the completion of the embankments these borrow pits were generally connected with the streams and formed two waterways parelleling the railroad. The farmers quickly realized the advantage of these canals in affording convenient assistance in cultivating, irrigating, and harvesting their rice crops. Where for fear of inundations it was not advisable to cut through the dikes to connect with the larger streams, the borrow pits



BORROW PITS REGULARLY EXCAVATED, AND USED, AFTER THE CONSTRUCTION OF THE LINE, AS CANALS FOR THE TRANSPORTATION OF BALLAST AND OTHER MATERIAL.

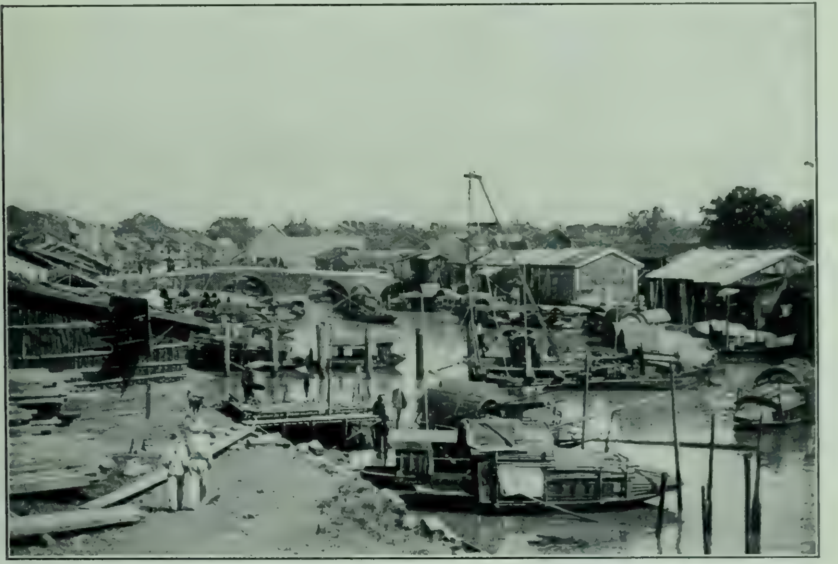


DRIVING PILES FOR BRIDGE FOUNDATIONS.

Below is shown the interior of a coffer-dam, with coolies engaged in cutting off piles for masonry. One of the wooden chain pumps, shown on a large scale on page 386, may be seen in the background.

adjacent to villages often were stocked with fish and afforded a supply of this food for the villagers.

The contractors in bridge masonry failed in the fulfillment of their agreements, because of the fundamental deficiency in the Chinese mind which could not conceive what it had never actually seen. Yet after the native had observed how the coffer-dams were constructed and filled, how the pile foundations were driven, how the concrete forms were erected and placed, how the cement, sand, and stone were mixed and deposited to form solid masonry, they were ready to proceed with other construction which involved these methods.



A BRIDGE SITE AT THE COMMENCEMENT OF THE COFFER-DAM WORK.

In the background is a Chinese village, with an ancient five-span stone-arch bridge.

Throughout this delta country the concrete abutments and piers of the bridges were founded upon piles, the timber for which came from the mountains hundreds of miles up the West River. Unless the expensive hard woods from the Straits Settlements or the Philippines or timber from America were imported, no other wood was obtainable excepting this China fir, which is similar but quite inferior to American spruce. The logs probably deteriorated considerably in their rafting from the forests to market, since this journey often consumed years. No difficulties were experienced with this work, although in one bridge adjacent to a sink-hole it was necessary to use spliced piles to a depth of 90 feet in the bridge foundations. The

CHINESE LABORERS DEPOSITING CONCRETE IN BRIDGE MASONRY.

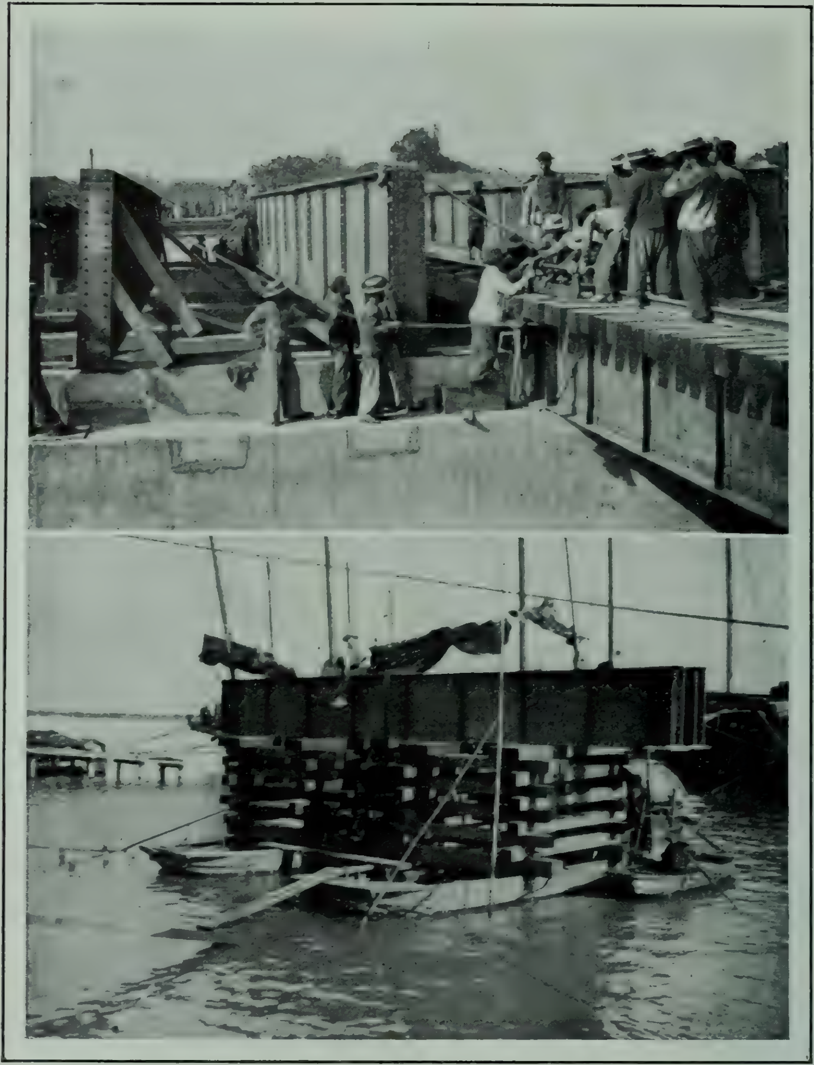
broken stone for the concrete was transported from the quarries a hundred miles up the North River; the sand was dredged from the river bottoms; the cement was an excellent product from Hong Kong and Macao, being locally manufactured there from the clay deposits near Green Island, adjacent to Macao, and the Ying Te limestone quarries of upper Kwang Tung.

The superstructure of the bridges was of steel girders, none of which exceeded 65 feet in length. It needed little computation to show the necessity of the reversal of western practice in economical span lengths. The cost of steel delivered at the bridge sites in China was so high, and the cost of masonry constructed by unskilled labor was so low, that economy pointed to short girder spans and numerous piers. The contraction of the channels of these tidal streams caused little or no erosion, and so long as an opening was left sufficient in width for the passage of the junks engaged in the commerce of that stream, no objection was made by the natives to the narrowing of the waterways.

The convenience with which the short spans could be transported in the small native junks to the bridge sites, and the ease with which they could be erected, were factors strongly advocating their use. In the construction of the main line to Hankow, no difficult problems of bridge construction will be encountered such as occur in the

CHINESE MASONS SETTING BRIDGE SEATS, AND CHINESE STONECUTTERS AT WORK.

Belgian line at the Yellow River, although some bridges of two or three hundred feet of span will have to be erected in the mountains. The types found economical on the Sam Shui division will be the standards in the main-line work.



ABOVE, CHINESE BRIDGEMEN ERECTING THE THROUGH-GIRDER SPANS; BELOW, GIRDERS CRIBBED UP TO BE SET ON THE MASONRY BY AID OF THE TIDE.

In the bridge erection, native labor was employed under the direction of foreign foremen. These coolies were from the shipyards and boiler shops in Hongkong and they soon became efficient bridge riveters. The erection of the steel structures presented no obstacles which were not easily overcome by this Chinese labor. The smaller spans were transported by junks to the bridge sites and, where possible, were placed on the masonry by aid of the tides. The larger girders were transported by rail and erected from temporary trestles as the track laying progressed.

CHINESE BRIDGEMEN RIVETING LONG GIRDERS.

In the double-tracked portion of the division, from Canton to Fat Shan, the rails were laid on steel ties of a rolled section with bent ends; for the single-tracked remainder of the line to Sam Shui, Japanese oak ties were used. The tracks were stone ballasted as fast as the leisurely working native contractor would supply the material; but river sand formed a temporary substitute so as not to delay the operating of the railroad.

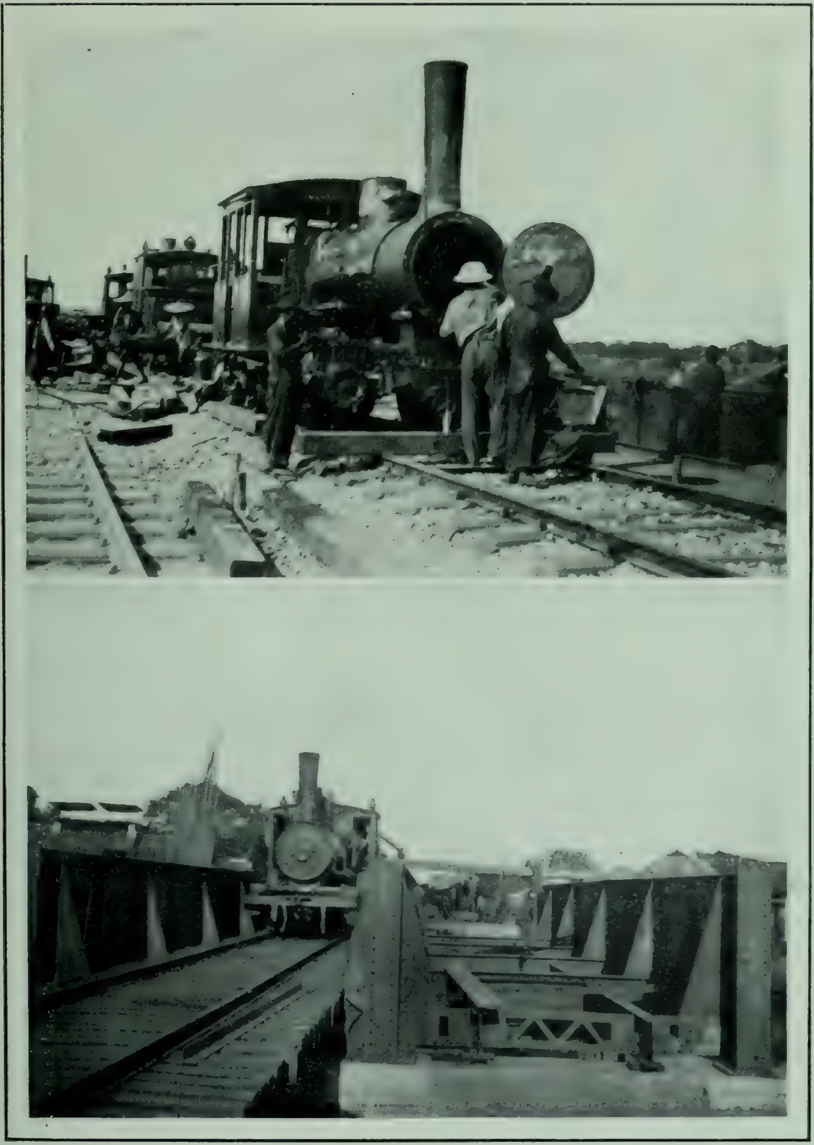
The economical type of track construction can only be evolved from experiments with the various kinds of rail support in this tropical climate of Kwang Tung. The enemy to everything wooden is the white ant, while to everything iron it is the humid atmosphere. Experiments were begun with ties of various kinds of wood, both from America and Asia, but the results of these tests can scarcely be apparent until after the lapse of several years.

The line to Fat Shan and later to Sam Shui was opened for operation with the ostentation, pomp, and noise which so delight the Oriental senses; the bedecked trains were greeted everywhere with volleys of firecrackers expressing the Chinese wishes for prosperity.

A CHINESE TRACKLAYING GANG MAKING UP A CONNECTION.

At the Fat Shan opening in November, 1903, the rolling stock was incomplete, so that flat cars with temporized sides and roofing composed the official trains. It happened that the opening occurred upon a Chinese feast day, so that it was necessary to devote two days to the opening celebration, the first being for the foreign residents

COOLIES STONE-BALLASTING THE LINE.

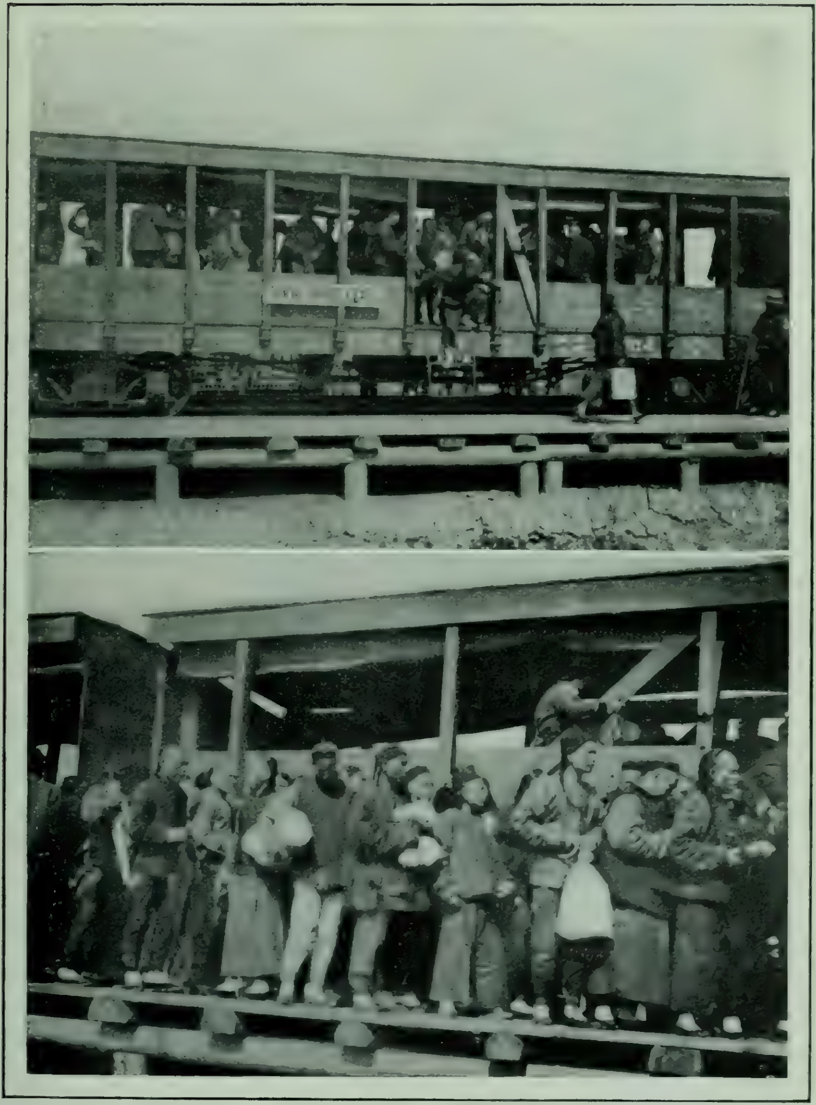


SOME OF THE FIRST MOTIVE POWER OF THE LINE.
The upper view shows the assembling of an old locomotive from the Manhattan Elevated R. R. of New York. The lower shows one of these engines in service, and the type of through girder bridge adopted.

and representatives of foreign governments and the second for the Chinese officials and mandarins. The event naturally proved of great interest to the whole country since it was the first display of a conveyance of such a character ever beheld in South China. If the railroad had been better equipped at the opening for the handling of passengers in accordance with western ideas, much greater pleasure would have been experienced by the engineers in displaying their work to the Orientals and the representatives of the foreign governments. Yet the Chinese had never seen better and to their conception of convenience and luxury, these cars proved attractive and comfortable.

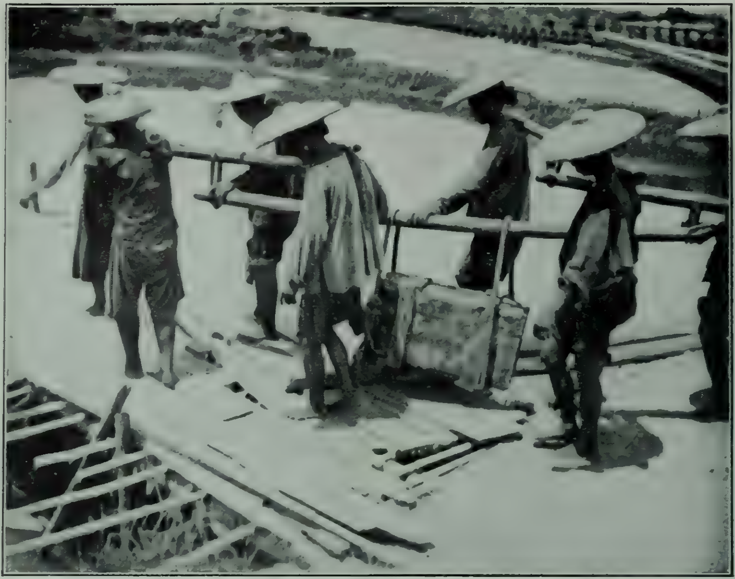
THE CHINESE OFFICIALS AND POPULACE AWAITING THE OPENING TRAIN AT FAT SHAN.

The division was operated for some months with these improvised coaches before the passenger cars arrived; the short runs were admirably adopted to the former Manhattan Elevated Railroad locomotives which were used in this division for passenger trains. This traffic was divided into three classes, as is customary outside of America. Some degree of comfort was provided for the first and second classes, but the third was carried in flat cars without seats or other conveniences. The apprehension that the Chinese people would prove too poor to support a railroad was quickly dispelled by the rapid growth of passenger traffic, which soon taxed the limited facilities for handling the patronage. The passenger rates per mile were, first



THIRD-CLASS PASSENGERS AND CARS.

The flat cars were fitted with temporary sides and roofs. The lower view shows a train load of passengers, just unloaded.



CHINESE METHOD OF MULTIPLE LEVERS IN CARRYING HEAVY LOADS.

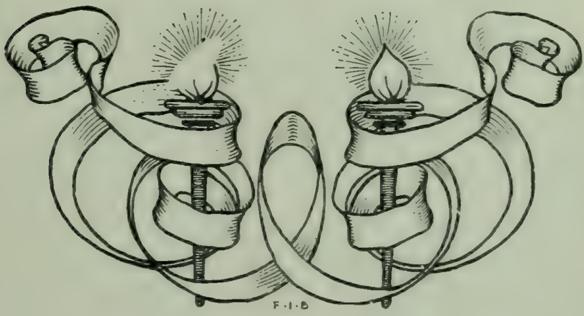
Suggesting a native attempt at mechanical aid to manual labor.

class, 5 cents (silver); second class, 2½ cents; and third class, 1½ cents. It is needless to say that the greater part of this traffic was in the third class, and the Chinese found it suited their pleasure to crowd in and squat on the floors of these flat cars in solid contentment.

The Sam Shui division will be used almost entirely for passenger traffic and in that capacity it greatly appeals to the Chinese on account of the quickness and the safety with which passengers can travel from Sam Shui to Canton. Previous to the opening of these 30 miles of railroad, this trip was from 40 to 90 miles by water and consumed from six to eighteen hours, dependent upon the means of transportation and the depth of the water in the various channels. These streams in the delta are infested with river thieves so that the voyage of a merchant with valuables is attended with much pecuniary risk and personal danger.

The construction of the main line north from Canton was commenced in January, 1904, but on account of the disturbed condition of affairs in the Orient, this work has proceeded slowly. Although the railroad thus far built and operated is a meager beginning toward the completion of the whole project, yet it is a successful effort and will serve as an entering wedge to open the Chinese minds to the realization of their errors of conservatism and superstition.

Regarding the efficiency of Chinese labor, the results of this railway construction would tend to give favorable reports. In excavation where the coolies are familiar with the work, the earth was handled at an extremely low figure; but when the embankment was high or the hill cutting deep, the methods known to the coolies were more expensive than if modern means and appliances had been used. It is a mistake to suppose the Chinese incapable of handling labor-saving machinery, and it is a mistake to believe that the employing of an inexhaustible supply of cheap hand labor is more economical than the training of the natives to operate machinery. The Chinese readily become skilful mechanics, and it needs merely capable superintendence to instruct and direct them in their work. As an illustration of the mechanical ability of the Chinese, all of the smaller steam craft and many of the ocean-going steamships in Chinese waters are operated entirely by Chinese engineers and firemen. In handling locomotives the natives quickly learn their duties; in bridge construction they prove efficient iron workers; in machine shops they become experts; in stone cutting, in masonry, in carpentry, in metal working, they are proficient in their crafts.



EXPERIMENT AND PRACTICE IN THE CONSTRUCTION OF STEAM BOILERS.

By Egbert P. Watson.

NEARLY forty years ago the leading engineers of that period met at the Centennial Exposition and agreed upon a rating for the horse power (so called) of steam boilers. This was the evaporation of 30 pounds of water per hour from feed water of 100 degrees to steam of 70-pounds gauge pressure, and it was based upon the average consumption of steam by well designed engines of the day; but since that time a great advance has been made in several directions, both in the boilers and the engines, so that the formula is no longer an expression of the capabilities of either. Notwithstanding the fact that there can be no such expression of the efficiency of a steam boiler, boilers are still rated by horse powers in buying and selling them. The only thing which fixes the power of a boiler is its ability to turn water into steam, and its true rating is the number of pounds it can deliver in a given time.

Horse power, as applied to a steam boiler, is a particularly unsatisfactory designation to all concerned, both buyer and seller, for the reason that there is no base to determine what a horse power is. An order for a 25-horse-power boiler would be filled by the builder with one having a certain number of square feet of heating surface, the grate surface being a subsidiary consideration, varying with the notions of the builder. Not many months ago I was asked to inspect a new boiler, just set up in a factory, which did not perform satisfactorily. It was intended to be a duplicate of another in the factory which had done well, and all the boiler maker had to do was to follow the copy. One boiler was set alongside the other and the stack was ample for both. In so far as heating surface was concerned there was no lapse, but for some reason unknown to any one (and not given by the boiler maker) he had cut off 18 square feet from the grate surface, which was the cause of its difficulty in making steam. The grate surface is a very important detail, but there seems to be no hard and fast rule for the ratios of grate to heating surface observed by the trade. The same is true of the smoke stack, and the whole procedure as to the proportions of steam boilers varies all over the country, except in the case of some insurance companies who prepare the designs of the boilers they will insure.

Fixing boiler power by the square feet of heating surface is a legacy from the days of Watt. The engines of that period were very defective mechanically, and required 62½ pounds of water for one horse power; the evaporation was very low, also—only 4 pounds of water per pound of coal; consequently, 15 square feet of heating surface were needed for one horse power. Even to this day this ratio is observed by some boiler makers, and this amount of heating surface is given in comparatively modern text books as essential to good performance. It follows that with modern furnaces, and a better knowledge of both the theory and practice of burning fuel to the best advantage, boilers are too large and, consequently, cost too much for a given duty. "Too much is just about enough" is, apparently, the rule for heating surface and other details.

Considering the wasteful and even reckless disregard of the cost of fuel by steam users generally, it is not surprising that the conditions named above obtain, for in the eyes of the average buyer a boiler is like a conjurer's bottle, in that it will furnish steam indefinitely, with any sort of mismanagement and any kind of fuel. Its functions should continue so long as there is a valve on it to open; when there is not, one or more can easily be attached. A short time ago a person bought a boiler of me for a certain specified duty; after it had been tried he declared that it was not up to its rating and demanded his money back. Investigation revealed that, in addition to the work it was sold for, there were two dye-vats with coils therein for which the boiler was expected to furnish steam. No sort of reasoning could convince the buyer that this was a great tax on the boiler, and he refused to be comforted. I thought to circumvent this weakness of steam users by stating specifically in a circular that boilers were sold on a guarantee to do the work named in orders and no other; but it availed nothing, for customers continued to hitch on steam pumps, heaters, etc., which demanded live steam, and complained as before that the boilers were not large enough. Purchasers of boilers should be careful to state every attachment to a boiler requiring live steam, and every use to which it is to be put, for in the event of a short supply they have only themselves to blame.

As stated in previous lines, boilers are still made by rule of thumb—or, to speak exactly, by methods which have given satisfaction to customers generally. Tables have been prepared, and published in all hand-books upon boiler making, which fix the power of certain types when so many tubes of a given diameter and length are supplied; but the builder must decide for himself upon the ratio of grate to heating surface and the diameter and height of the stack. As these last have great influence upon the efficiency and economy of a boiler, it does not seem as if the boiler maker gained much by having the heating surface alone furnished him. It goes without saying that every boiler which has a specific duty to perform should be designed for it, but so long as steam users continue to guess at the power they require, boiler makers will continue to guess at the size they need.

It has been asserted in previous lines that the rate of evaporation a half-century ago was very low—from 4 to 5 pounds of water per pound of coal only—and corroboration of this fact is found in an experiment made in 1858 by B. F. Isherwood (formerly engineer in chief, United States Navy,) upon a boiler in the Brooklyn Navy Yard, which was, as boilers were then built, typical of its kind and class.

The boiler was of the drop-flue type, 48-inches diameter by 24 feet long, having five flues 12-inches diameter by an average of 15½ feet long. The heat entered the upper row of flues first, then descended to the row below, and finally dived into a large horizontal flue from which the gases went to the chimney. The boiler was set in masonry and had a total heating surface of 379½ square feet; the grate surface was 19½ square feet, and ratio of one to the other nearly 20 to 1. The evaporation per pound of good coal was from 3.60 to 4 pounds only, with feed water at 100 degrees. This is a very poor performance, apparently, but the consumption of coal was only 9.67 pounds per square foot of grate, using forced draught at that. A modern Lancashire boiler, which is very much of the same type, will easily burn 24 pounds of coal per square foot of grate with natural draught, and evaporate 8 pounds of water per pound of coal.

Another boiler experimented with by Isherwood was the Ellis, very similar to, and indeed almost identical with, the modern return-tubular boiler in universal use to-day, both in proportions and results. It evaporated 9.07 pounds of water per pound of coal from 100 degrees feed water to 35-pounds gauge pressure; from and at 212 degrees the evaporation was 11.57 per pound of combustible, which, says the author, "was a very mediocre result." If it was it has not been improved upon in nearly half a century.

In view of the moot point—the relative merits of fire-tube and water-tube boilers, still discussed—it is interesting to note Isherwood's conclusion from experiments carried on with two boilers of the kinds mentioned, of very nearly the same dimensions, in the same vessel—

the San Jacinto, U. S. N. It was intended to be a "rigorously comparative experiment," there being no differences except in the types of the boilers. The observers, or experimenters, were B. F. Isherwood, William E. Everett, John Faron, and James A. King, all chief engineers of the Navy.

Without burthening this article with repetitions of figures it is only necessary to say that the boilers were identical, with one exception:—the water-tube boiler had 27½ per cent. more heating surface than the horizontal fire-tube boiler, the grates being the same in both boilers. The very low rate of combustion, however, and the pressures carried—10½ pounds for the fire-tube boiler and 11½ for the water-tube boiler, burning only 9.68 and 8.92 pounds of coal, respectively—deprive this experiment of the interest which would have obtained had the conditions been more like those with the vessel *en route,* doing her best. Summarizing the results in the words of the demonstrators:—

> "If the maximum absolute weight of the steam that can be procured in equal times be alone considered, the horizontal fire-tube boiler for equal dimensions has an advantage of 10½ per cent. over the water-tube boiler."

This verdict is qualified further on, in a more exhaustive analysis of the performance (page 168, Engineering Precedents, Vol. 2) by these words:—

> "The weight of steam furnished in equal times by both boilers being equal, and equal space being occupied in the vessel for both boiler and coal, the vertical water-tube boiler at its maximum rate of combustion has the great superiority of furnishing 27½ per cent. more total weight of steam than the horizontal fire-tube boiler at its maximum rate of combustion, while at the same time the aggregate weight of boiler and coal will be the least."

It is interesting to note in these boilers of 1858, forty-six years ago, that the horizontal fire-tube boiler was, to all intents and purposes, the counterpart of the Scotch boiler, so called, in use today, except that it had water legs, while the water-tube boiler bears no resemblance to the modern boiler of its class. Externally it was the same as the boiler of the period, having a shell all over ⅜-inch thick, internal firebox, water legs, and water bottom, and a cumbrous uptake where the gases emerged into the smoke stack. Moreover, the tubes were vertical, but the products of combustion passed through them transversely, so that the action of the heat was the same as if the tubes had been horizontal. This was a Martin boiler designed by a chief engineer of the United States Navy. There was a solid bank of brass tubes of 2-inches outside diameter, 3 feet by 7 feet, through which the gases and products of combustion passed; the tubes were spaced 3½ inches from center to center, with ample space above and below to clean them, and with distilled water from a surface condenser the boiler would doubtless have given a good account of itself; but its rate of evaporation on the San Jacinto, which had a Pirsson condenser, was not high—only fair—being but 7.8 pounds of water at a feed temperature of 100 degrees, per pound of coal.

Small tubes in boilers were looked at askance in those days, and it was predicted that these would soon become clogged by scaling, unless fresh water was used. This was practically impossible at that time, for surface condensers had not come into general use, jet condensers being the rule on all sea-going vessels. As a consequence tubulous boilers soon lost their efficiency, and the Martin boiler was no exception. I have seen boilers of this type after a trip from Havre to New York (on the steamers Arago and Fulton) come limping in with 5 or 6 pounds of steam, it being impossible to get any more owing to the tubes being chock-a-block with salt, or a saline stone which was like flint for hardness.

So many of the tubes were affected in the way described that the heating surface was cut down materially; those not absolutely solid with scale were so covered internally that the waterway was not over ½ inch in diameter. This might have been caused in part by mismanagement, but it occurred trip after trip, after the engineers had become familiar with the boilers' peculiarities, it being practically impossible to prevent it where salt water in any quantity was fed.

Respecting the design of this boiler, it is apparent that it was not a water-tube boiler pure and simple, but a compromise between a fire-tube and a water-tube boiler. It had legs and a water bottom which needed stay bolts, and an exterior shell which had to be braced; as a consequence, it was but a few pounds lighter than, and took up just as much space as, an ordinary steam boiler. In view of these features it gained nothing by comparison with the usual boilers, except a slight increase in evaporation and economy, with a longer radius of action. Contrasting it with modern water-tubular boilers it appears at a great disadvantage; our forebears had not then learned the trick of dispensing with the shell of a boiler and likewise the steam dome, substituting for the latter appurtenance a drum which occupies but little space and fulfils all the conditions. It is noteworthy, too, that while the modern water-tube boiler has achieved extreme lightness, the fire-tube boiler has gone the other way and is enormously heavy. The improvements made in it consist of removing the legs and water-bottoms and making it cylindrical externally. To enable it to carry the higher pressures demanded by modern practice, the shells have been greatly increased in thickness, and braces and stay bolts as well; the weight of boiler plates used a half-century ago was about 12½ pounds per square foot, but now the shells of high-pressure marine boilers will weigh from 40 to 50 pounds per square foot. Evaporation, however, has been doubled, while the amount of coal which can be burned per square foot of grate has been raised from 9 or 10 pounds to double that quantity with natural draught only.

Of the boiler itself it is scarcely necessary to speak, for there is no comparison between the steam generator of today and that of fifty years ago, in material, design, or workmanship. Steam boilers in these days are as carefully made as engines, and should have a much longer life.

This dissertation would be incomplete without some reference to the thermodynamics of the subject, which to the enthusiastic student of boilers is one of the most interesting branches connected with it. It is, in itself, an abstract study, because so much must be assumed as a base for argument, but that which is known or accepted as fact claims attention. For example:—the possibilities in the burning of one pound of pure carbon in a laboratory are the evaporation of 15 pounds of water, and essayists dwell upon this point in comparing the efficiency of modern furnaces and the amount of water evaporated in practice. But between the chemical laboratory, so to call it, and the crude retort of the steam-boiler furnace there is a very wide margin for error and loss of efficiency. For one item, the fuel itself is by no means pure carbon, or anything approximating to it; analysis shows that the constituents of commercial coal vary greatly. Even in the mine itself this difference shows; but it is all "coal" to the steam user, and he must do the best he can with it. After he has the coal, it is thought sufficient to shovel it into a furnace of some sort—let in too much or too little air, and take the chances of evaporating more or less water for every pound of it. Firing a steam boiler for high efficiency is by no means a handicraft, but a study of all the conditions prevailing for every plant, and it is rather creditable than the reverse that we are able to realize even half of the theoretic value of the fuel. If the demonstrator in the laboratory burned his carbon in the same manner he would not get an evaporation of fifteen pounds, either. Consider, also, the condition of the vessel in which the water is evaporated into steam; it could scarcely be worse than it is for economy and efficiency. The average steam boiler, unless carefully prepared for experiment previously, is in no condition to boil water efficiently, and the devil-may-care methods of firing by the hands of a common laborer result in half of what is, or should be, coming to the man who buys the coal. This should not deter experimenters from prosecuting their researches further in efforts to bring out a furnace which is fool-proof, so to speak. Some of these are in existence now, but as they require skilled labor and attention, the steam user is slow to adopt them because he has to pay more for brains than for main strength and stupidity.

No one has more carefully investigated the thermodynamics of the steam boiler and its furnace than B. F. Isherwood; his analyses and connotations of what takes place in the furnace of steam boilers are not only exhaustive, but are very probable from a practical point of view. Although made nearly fifty years ago, his diagnoses will fit modern conditions as well as they did the crude boilers of his investigations. It is not difficult to formulate hypotheses upon any moot point, and suspend them by exceedingly tenuous ligatures to alleged problems met in practice; but when it is sought to apply such theories in daily work they are not found available. It is here that the vaticinations of Isherwood assist, for they are not only plausible but probable from the standpoint of the practitioner.

I quote a short excerpt from "Engineering Precedents," a work now out of print, which shows Isherwood's conclusions from an experiment with a tubular boiler. He found that different temperatures existed in the upper and lower rows of tubes and explains the matter in this way:—

> "We have seen that with the horizontal fire-tube boiler, the temperature of the heated gases emerging from different horizontal rows of tubes varies enormously—probably 300 degs. F. for the extreme top and bottom rows. Now, to what are we to ascribe this great difference? Is it to the fact that the gases find the easiest exit through the top rows, and that the calorimeter of these rows is sufficient to pass them with such facility as to rob the lower rows of their proper share, leaving them thus comparatively inoperative as heating surfaces? Or is it because the upper rows, in consequence of being enveloped in the total mass of steam developed by the furnaces, and by the lower rows lying beneath, are not in contact with enough solid water to reduce the temperature of the gases passing through them as low as the temperature of gases emerging from the lower tubes, which, lying in the steam produced in the furnaces only, are in contact with much more solid water and produce a higher economic evaporation from the more complete absorption of the heat of the gases? The latter is undoubtedly the true cause. The upper rows of tubes must necessarily be surrounded with a mass of mere foam, composed of water finely divided by and mixed with the steam generated from the lower

> rows of tubes and the furnaces; in fact, nearly all the steam produced by the boiler has necessarily to pass between the tubes of the upper rows, displacing the solid water and replacing it with a soap-bubble like mass, possessing a far less heat-absorbing power. The result is that from the lower row to the upper one the tubes have a continually decreasing evaporating efficiency, owing to their absorbing a less and less amount of heat as we ascend, and, as a consequence, delivering their heated gases into the chimney at a continuously increasing temperature. . . . The economic evaporation of the tubes is then very greatly affected by their distribution, the maximum, *ceteris paribus,* being obtained from the fewest number of horizontal rows and with the widest spaces between the tubes.
>
> "But this desirable arrangement can only be remotely approximated in practice, owing to the fact that the number of vertical rows is limited by the breadth of the furnace, and that, in order to place in this space the greatest number of these rows, the distance between them must be reduced to a minimum; at the same time the necessity of providing a proper proportion of heating surface and of calorimeter compels recourse to the maximum number of horizontal rows; and thus we finally obtain a boiler that satisfies the numerical proportions by ignoring physical laws and paying the penalty in a reduced evaporation."

This must suffice for direct quotation, but Isherwood suggests a remedy for the unequal distribution of heat in the tubes of the average tubulous boiler, which is to decrease the diameters of them from the bottom row upward; retaining the same number of rows, vertically and horizontally, but reducing the calorimeters in each horizontal row in the ratio of the squares of their diameters, the velocity and mass of the gases through them will also be reduced, and more time given for the absorption of heat. Although the heating surface *per se* is reduced, its efficiency is increased, so that the evaporation will be even greater than if all the tubes were of the same diameter throughout. The remedy for the unequal distribution of the heat is thus clearly pointed out, but I do not recall that it has ever been adopted by any one. Isherwood says that the diameter of the upper rows of tubes should be only two-thirds that of the bottom ones, and a space of 45/100 of their diameter between these last; by restricting the height of all the rows to 30 inches by making the aggregate calorimeter to one-seventh of the grate surface, and so proportioning this to the total heating surface measured on the *interior* of the tubes that it shall be as 1 to 28, we shall obtain the highest economical evaporation consistent with natural conditions.

"Natural conditions" applies directly and pertinently to boiler-room practice, and nowhere more appositely than in the burning of coal. Treatises upon the combustion of coal abound, but a man who can not read or write will make the most recalcitrant boiler furnish steam, when another man who can accurately distinguish carbonic acid from carbonic oxide in a furnace has no steam. This is no disparagement of a knowledge of the laws of combustion, for all information that applies is of value at some time, but there is nothing within the scope of everyday engineering that is more baffling than these same laws.

All science is at fault at times, and though there is every reason present why a boiler should steam it simply will not. On such occasions every one takes a hand at the fires, but the result is the same—no steam, or only enough to keep three-quarters speed. A variety of causes combine to produce this condition of affairs; while slight in themselves, their aggregate effect is to paralyze the motive power for the time being, or until the deadlock is removed by a change of wind, or course, or by taking coal from another bunker. This last has been known to furnish a remedy for a sulky boiler as soon as the fires were cleaned and new ones started with fresh coal, showing clearly that the fuel had a bad streak in it. Marine and stationary boilers are afflicted in the way described; there are "good days" and "bad days" in the performance of both.

"Steam is king, long live the king" can scarcely be said in these days, for since the improvements in explosive engines its supremacy is seriously threatened. This is true of both large and small powers and plants, but especially of the former. Time was, not so very long ago, when steam launches were common on all the waters of the country, but there is not one now where there are hundreds of explosive engines which require no boiler. In establishments of every kind which require power of some sort, there are gas, or gasoline, engines in the place of steam; it would be rash to say that the days of steam prime movers are numbered, but it is within the facts to say that they have seen their best days. Gas engines of enormous powers are being installed daily, in Europe certainly, and will be in the United States sooner or later. In view of these facts it will be difficult for steam to regain its lost prestige; for consumers, when they find that it is cheaper to turn coal into gas and use it in an explosive engine than it is to burn it under a steam boiler and employ it in a steam engine, will promptly abandon the latter. For certain operations where steam is required for other purposes than power it will be poor economy to dispense with a steam engine, but in the widely extended use of gas, gasoline, and electricity, the radius of action of the steam engine has been much reduced.

SYSTEMATIZATION AND TOOL-ROOM PRACTICE IN A RAILWAY REPAIR SHOP.

By R. Emerson.

I. STANDARDIZATION AND GENERAL ORGANIZATION OF THE TOOL-MANAGEMENT SYSTEM.

The peculiar conditions present in the railway repair shop seem to have delayed, for a long time, the effort to extend there the economies of production which are taken for granted to be essential to the successful manufacturing establishment of today. One of the most interesting movements to the student of production engineering, therefore, is the present rapid extension of its principles and practice into this tardily opened field. Mr. Emerson has been intimately associated with some of the largest and most original work in this line. This gives the primary interest to his article. Its secondary interest lies in the fact that most—if not all—of the practice he suggests is profitably applicable to any shop large enough to have a tool room and a tool system. A second paper, of which this is yet more strikingly true, will follow in a later issue of this Magazine and will deal with the care and upkeep of the small-tool equipment.—THE EDITORS.

RAILROADS are conducting a transportation business, not running manufacturing shops; none the less the laws of economy governing competition in commercial establishments play their part as certainly, if less evidently, where pressure of works-production rivalry is is not so immediate.

This article is to present only some of the practical advantages of a well worked out tool system, and cannot describe at length the mode of establishing such a system over an entire railroad and the functions of each branch. We shall therefore assume the road to run under a certain set of conditions:—it is a thousand or so miles long; it has several "divisions," each with its round houses and shops, one shop being the main one; it operates 500 or more locomotives. The road has probably grown by acquiring smaller properties, and consequently variety of "power," although there may be numbers of later locomotives in definite and few classes. Owing alone to the large proportion (and many of a given class) of locomotives passing through the main shop, the manufacture of parts tends to become reduced to definite practice, and standardization of equipment for this shop's division (and then for the road) is the next obvious step. Drawings of standard parts are made and these parts applied whenever engines passing through the shops require such renewal. New engines have standard parts specified in contract, these parts being made to company blue prints. Changed shop requirements and repair methods result from this new policy. With standard equipment it becomes possible to concentrate manufacture and get the cheapness of quantity-production. The tendency, then, is toward the regulation, by the engineer, of method of production as well as of design, and the carrying on of this production to this design under his supervision. The locomotive is built or repaired so far as may be in the shop by machine, the erecting floor being limited as far as may be to mere assembling. Such redesign must in a sense precede attention to the tool facilities; yet the methods of manufacture, tools used, and operations needful, should be considered parallel with the consideration of design; and design should be modified to accommodate method, as well as method devised to produce design. We are to consider relations of tool management to this condition of standardization of equipment, with consequent alteration of shop methods.

System as applied to one small tool room is a paying investment in the tools saved and in the facility with which the proper tools are available when wanted. System as applied to the tool regulation on the whole railroad pays not only to this extent, but to an even larger degree in the standards it is possible to establish, and in the decreased cost of production due to manufacturing locomotive parts by these standard tools on large scale, and accurately, so that they will fit in distant round houses. The methods suggested in this standardization of work (which is always dependent upon the tools) are closely akin to those now used in building locomotives in batches. Frame bolts are a case in point. In the locomotive works these are furnished in quarter-inch lengths, and in standard tapers. Holes are drilled and reamed according to these standards. All fits well. In the locomotive repair shops the customary method has been to ream out the old frame-bolt hole with standard-taper reamer, but without any given diameter. The bolt was then either completely forged up from the rough and cut off and turned to size, or else was so turned and fitted from a blank size in stock. In either case much individual labor was needed on each bolt. The new method would call for a series of diameters of these taper-bolts varying by 1/32 inch. An engine passing through the shops would have all her frame holes reamed out to the size next larger than the one previously used. This could be done with a standard shoulder reamer of high-speed steel, the resulting hole perfectly accommodating the bolts in stock. Such a stock of bolts from one of the large railroad systems in this country represented an investment of less than $1,200. Needless to say the interest on this sum and on the somewhat more expensive tools was insignificant compared to the greater expense of putting in bolts in the old individual way. It is the province of the tool man to care for these reamers and to keep them to standard. In order to do this properly, a tool system is needed whereby it will be impossible for a man to have one of them in his possession long enough for him to wear it below standard size.

Railroads use tools of all kinds; it is difficult to say whether the investment in small tools or in machine tools is greater. While the former are individually cheaper, they may be collectively more costly.

One of the most important features of small-tool equipment is the air-tool service. These tools for the money invested in them do giants' work, but on account of the severe strains to which they are put they suffer frequent disorders. Unless this branch of the service is rigorously supervised, constant trouble and vexatious delays will result. From figures in my possession I find that the maintenance and repair charges on pneumatic tools range from 60 per cent. to 90 per cent. per annum on the purchase price of these tools, without counting the depreciation and interest charges, which in the case of tools with life so short as these are very high—I should say, combined, an additional 100 per cent. In fact, this maintenance and repair cost, together with the purchase price of the tool, will average somewhat above $200 per annum, this figure applying equally to motors and hammers. As it is false economy to do work by hand that can be done by air, and as there is much work that can be done more conveniently and cheaply with portable air tools than with stationary machine tools (such for instance as chipping chamfers on locomotive frame jaws in place, or the miscellaneous drilling and tapping on boilers), the larger the number of air tools engaged in productive work the cheaper the output costs. And yet in a shop where a hundred or more such tools are in use (the figure of one motor to every ten men on the total pay-roll of the shop, or rather one machine for every six men engaged in boiler or erecting work, is a safe one) the expense amounts, of course, to a great deal, and most careful supervision amply pays for itself. As in the case of arrangement of tool rooms, the distribution of air-tool equipment will vary according to circumstances. A good practice is to allot a fixed number and style of machine to each gang of men, providing lockers for the storage of these machines at night, and holding the gang foreman—or he holding one of his men—responsible for the proper keeping of these machines. Of course there must be a dozen or a dozen and a half extra machines in the tool room for special use. At the end of each week all motors and hammers are turned into the tool room, where they are thoroughly inspected, cleaned, tested, and if needed, repaired and adjusted. It may be mentioned in this connection that it will be difficult to find a careful man with sufficient skill to keep these delicate machines in first-class order. It may also be pointed out that such a well defined system of maintaining air-tool efficiency, as opposed to the common method of effecting repair only when it is absolutely necessary, involves for its most economical working the standardization of this pneumatic equipment (that is, limitation to only five or six sizes or types of machine) and the keeping in stock of all spare parts. It will be found that many motor parts can be made much more cheaply than they can be bought from the manufacturer, and often design may be altered or simplified right in the shop.

This system, while it seems to cost something in the fact that one skilled man at least is engaged in nothing else but air-motor repair, is in reality not only cheaper in its supervision cost, but also is a great deal less expensive than when the spare parts are purchased or motors sent to manufacturers for repairs.

One large railroad company had its pneumatic-tool account rising steadily for the past five years, *averaging* over $15,000 per year for new tools, and material and labor repair charges alone. This account had not been systematically looked after, tools being battered around the shop till it was no longer possible to effect simple repairs and adjustments, when they were sent to the manufacturers for thorough overhauling and replacement of parts. The practice obtained of men seizing what motors they could lay hands on and using them, often carelessly, until the machines would no longer give good service or run at all. There was practically no one to raise the question except the man using the machine or the shop foreman who was interested in the output of the work, or the tool-maker who was delegated to make repairs—each of these men being powerless to effect any reform or establish any system or incite any interest in the matter of properly handling these tools as a general proposition. But when the master mechanic himself awoke to the importance of this matter, because on the one hand of the curtailment of his requisitions for additional air-tool equipment, and because on the other hand of a long-drawn howl on the part of the shops for increased facilities in this direction, he set a special apprentice to work to see what could be done and saved by means of an efficient system. One similar to that above outlined was slowly evolved and installed; the net result of this system of holding men and foremen responsible for machines definitely assigned to their charge, together with the enthusiastic co-operation and ingenious handling of the repair question by the tool-room foreman, was a reduction in cost to less than $5,000 per year, not counting interest, depreciation, and fixed charges. This saving represents the interest at 4 per cent. on $250,000.

These figures take no account of the saving of the men's time due to increased use of air tool equipment and more efficient performance of same in service, as these savings being indirect though great, could not be determined. There was, however, a vast difference noted. Whereas formerly there were daily complaints and quarrels between the men, clamoring at the tool room, bothering of foreman, chasing about the shop by the half-hour in search of motors, the smoothness of operation of the new system and the fact that it was answering the requirements placed upon it were evident from the ceasing of the uproar of previous times and from the satisfaction which all concerned took occasion to express when asked respecting the change.

The tool room has been treated so far as simply a convenience to the shop, but it may be far more. It may instil the very breath of life into shop operative economies; it may be the origin of manufacturing methods upon whose practicability and cost-saving features the success of the shop as a commercial proposition rests. Of course, one must have a man, one with large ideas, experience, and inventive fertility—presumably an expensive man—at the head of this tool system. He will see to it that the tool room furnishes templets, jigs, and tools for the rapid production on large scale of standard parts, before it is forced to do so by the reiterated demands of some of the more progressive foremen; in other words, that the tool room shall be leading the shop. The tool accounts on western American railways vary from about $100,000 to $500,000 per year, and must reach over a million on such systems as the Pennsylvania. This sum sounds expensive for a mere incidental to locomotive maintenance; and it *is* expensive—extravagantly so—unless it is intelligently spent. Should this amount, however, be doubled, three or four times the additional expenditure could be saved in cost of locomotive repairs. It can be authoritatively stated that when tool expenditures are well systematized, the efficiency of the system as a manufacturing output cheapener is not only manifolded, but the actual cost of operating the system itself can be materially reduced—from 12 per cent. to 20 per cent. in cases under my own observation.

A few samples of the way this inventiveness can help not only the central shop but the whole road may here be given. It was calculated that if it were required to lay out more than one side-rod, it would pay to lay out a sheet-iron templet, the latter to be used in laying off the two or more rods instead of measuring these up individually. The cost of the templet was therefore a credit rather than a debit sum. Similarly for cylinder-head templets and drilling plates for front ends and flue sheets. This for the individual shop. For the whole system the tool room may standardize the manufacture and application, as noted above, of frame bolts, or of knuckle-joint pins, or staybolts. The methods in the case of the last two items were very similar. For the pins, standard "taper shoulder" reamers were provided for each size or class of pin, the number of such classes being reduced to a minimum—in the case I have in mind, four. Each class or nominal size was provided in four diameters varying by 1/16 inch. All new work was reamed to the first and smallest diameter, and at each subsequent overhauling to the next larger diameter. The use of these shoulder-reamers and their distribution to every shop and roundhouse of any size on the railroad system made possible the manufacture of these pins by turret-lathe methods, to standard diameters and in large quantities, and the distribution of these pins as stock to the points where they would be needed, thus saving entirely the expensive method of turning each pin separately as occasion required and time pressed. Staybolts also are made very accurately to standard diameters varying by 1/16-inch and 1/32-inch, and to various lengths, sample staybolts of each lot being accurately gauged for size by limit thread guages. Stock of these bolts is distributed in similar fashion to that of frame bolts and pins, accurate fitting of the staybolts being insured by the maintenance, by frequent inspection throughout all the shops, of standard size of staybolt taps. When this manufactured stock of staybolts is first furnished a complete canvass of every staybolt tap on the road is made in person, by someone competent for the job. These taps are permitted to be used only while they are within 3/1000 of size, all others being scrapped. Small V limit gauges are provided at each point for the local tool man to test his taps for size. Thus staybolts manufactured centrally may be applied anywhere.

Not only must these methods be devised and the prejudices of local foremen with their own ideas, be overcome in their introduction, but also the man who has originated and carried out these plans must follow them up unceasingly so as to keep up the cheapness of work once attained. This man whom we have placed in charge of the tool arrangements over the entire railroad will be the most expensive man of all, yet he will justify his salary not only by the savings he effects in operative costs, but also in many indirect ways. He can conveniently supervise all requisitions for tools of every kind, machine tools included; with his expert knowledge he can distribute tools among the various shops, and in fact designate the character of the work and its distribution in the most effective way; he can check the accumulation of surplus stores of machined parts; he can test and report on all new processes that come up—such as determining whether, where, and how to use this or the other brand of high-speed steel; whether shoes and wedges should be planed or milled; whether piston rods should be finished on the lathe or on the grinding machine; to what extent it pays to go into electric-motor driving.

Tools produce the work; therefore tools determine cost. And unless you have an able man as the keystone of the organization of men who are to use these tools and produce the work (I refer to my general-tool man), nothing will result from lifeless system alone. But just as the successful application of such system depends on the man, so, too, does the highest manufacturing efficiency depend upon the following cardinal principle:—that all tools, of whatever nature, should be worked to their maximum effective limit. This necessity is a transient aspect of our rapidly changing arts—an aspect which is likely to continue for the next generation or so at least. Owing to the rapidity with which we are gaining insight, not only as to the nature of materials but also as to methods for working these up most usefully, practice of today is so far refined on practice of yesterday that the art of yesterday deserves to be lost. What is true of steel bars forged into cutting tools will apply with equal force to complicated machines having an effective working limit. If men and work were pushed to maximum production it would probably pay to scrap a shop's entire machine-tool equipment every two years; it would certainly pay to do so every five years; and this because, if worked to their limit of capacity, these tools should turn out in this short time a product many times their own value, thus quickly paying for themselves in usefulness, as quickly outwearing that usefulness by intensive production, then giving place to newer and later tools with a still greater effective-production limit. The time may come when processes will be so well worked out that it will pay to spare the machine in pushing the work; but that is still far off, and we of the present are concerned with this different set of conditions. What is true of these largest groups of machine tools is even more true of the small hand tools; the faster these can be worn out—not broken—the better it speaks for the way shop work is pushed. The man at the head of this tool systematizing should not hesitate to substitute a smoothly working idea for an inefficient mechanism of metal—should, while constructive in plans, be destructive of what fails of requirements when he deals with machines.

EDITORIAL COMMENT

IN the First Labor-Saving Number of this Magazine, which appeared in March last, we pointed out that "there is no act of manufacture, no stroke of construction, no detail even of household work, in which at some stage labor-saving does not play a vital part." And there is no line of human activity in which this is more apparent than in the movement of materials. It is almost staggering to measure up how large a proportion of all the work of the world is included under this head. The navvy in the ditch—the machinist at his lathe—the artist at his easel—each is engaged in moving certain predetermined materials to or from certain exact positions. Throughout almost this entire range, the skill of the inventor and the engineer has found embodiment in devices for lightening manual effort, and enabling the worker to multiply the value of his production by concentrating his skill upon his higher functions.

Mechanical transport, therefore, furnishes the widest range of expression of labor-saving machinery; to it in its manifold applications, and especially in those which apply to mining and metal working, we shall devote the next number of THE ENGINEERING MAGAZINE. Our issue for January will be the Third Labor-Saving Number, completing the series proposed last spring.

* * *

THE Panama Canal is the largest concrete proposition—the largest single example of the application of mining and mechanical handling and transport machinery—now before the world. Prof. Wm. H. Burr, member both of the Isthmian Canal Commission appointed by President McKinley in 1899, and of the present Panama Canal Commission charged with the plans and execution of the work, will occupy the leading place in this special number with a concise account of the actual condition of the undertaking—that is, the legacy of work, *materiel*, and plans and surveys received by the present commission from former ones and from the French company—and the nature of the work now being carried on upon the Isthmus. It will clear away many misapprehensions which have been raised as to the facts of the case, and give a definite idea of the basis upon which the great project now stands.

* * *

IN a leading article elsewhere in this issue, Mr. Haskell discusses the important subject of railway accidents in the United States, and rightly attributes many disasters to the tacit disregard of rules and methods of signalling. Any one who is at all familiar with the operation of railroads in the United States must acknowledge the truth of the charge which he plainly makes, namely, "that the admirable rules for the government of employees are habitually disregarded;" but the very admission of the truth of this statement is also an admission of the inadequacy of the mechanical safeguards which are at present in use.

The only way by which the disregard of signals and rules can be prevented is by making it physically impossible. The engineer must have no discretion as to whether he will stop or run past a block signal; he must be stopped by a mechanical device, the release of which is beyond his control.

The introduction of such devices is not difficult nor impracticable, and there are numerous methods by which they may be effectively employed. The derailing switch is well known, and no engineer who realizes that the passage of a block signal means the ditching of his train will willingly run into such a certainty. This, however, is not sufficient, as the engineer may not even realize that the signal is set against him. The setting of the block signal should also set his brakes automatically for him, if he disobeys the warning, and hold him ignominiously stalled until he is released by the opening of the block. The rear protection may be equally controlled by setting a trip for the operation of any following train which may approach within the danger limit, and thus the element of discretion be wholly elimated.

* * *

In a certain large city there occurred, several years ago, a number of accidents upon passenger elevators, these being clearly traceable to the practice of the operators of opening and closing the doors while the car was in motion. Like the current methods of train operation, the rules requiring the car to be brought to a full stop at the floor before the door was opened, and also requiring the closing of the door before the car was started, were generally ignored, and the results were apparent in numerous and fatal casualties.

By the passage of a suitable ordinance it was made obligatory to equip all passenger elevators with interlocking stops, which rendered it impossible to start the car while any door was unhooked, the hooking of the door releasing the operating lever in the car, and the presence of the car exactly opposite a given floor being necessary before the door could be unhooked. At first there was some delay in the service, but in a very short time the operators became as expert as they had formerly been careless, and the cause of the accidents was entirely removed.

* * *

The delegation of responsibility to employees is a matter of great importance, especially where human safety is involved, and it cannot be entirely removed; but it is entirely practicable to limit it to positions where it can be exercised without fear or favor.

In the case of train operation, the modern signal systems are designed to place the element of responsibility upon the operator in the signal tower, and experience has shown that this is all right. To permit disobedience to the signals to nullify the safety element in the whole system is both a crime and a blunder, and until the possibility of the disregard of the signal by the engineer is removed, no rules, however carefully devised, can be of avail. The passage of a block signal by a train should be made mechanically and physically impossible, and in like manner should the approach of a train in the rear be mechanically limited to a determinate distance.

* * *

The promised reforms in the New York post office are of far more than local importance, for more reasons than the obvious one that the leaven introduced there might be expected to spread to the other large offices of the country. New York has long been the *entrepôt* for most of the foreign mail of the country; with the rise and rapid growth of the custom, especially among the large engineering manufacturers, of establishing a chief sub-office or sales office there, even though the main plant and management be centred elsewhere, New York has grown in importance as an exchange or clearing house for domestic business communications. Anything facilitating the movement in the New York office quickens the whole network.

To an observer of conditions as they are, the most apparent need is greater fluency of movement within the New York post office. Its external exchanges, especially its long-distance exchanges, seem well arranged. But the internal postal communication is grotesque in its inadequacy. It is rare indeed that a city letter is received by the addressee the same day it is mailed, and such a thing as exchange of original communication and reply within the business day, by use of the mails, is hardly even thought of. In fact, most business houses place so little dependence on the prompt carriage of their local letters by mail that everything except urgent matter (which is entrusted to private messenger) goes until evening and is dumped into the office with the out-of-town correspondence. It is more convenient so, and reaches its destination just as soon—i. e., the next morning. And yet that destination may be only a few blocks away. If the contemplated reforms should take the direction of giving New York some such an internal postal service as London enjoys, for example—say an average interval of three, or even four, hours from the mailing to the delivery of a city letter—the immediate result would be a more even distribution of the mail received in the drops throughout the day, a marked relief from the overwhelming influx during the evening hours, and a most valuable gain in time to correspondents all over the United States.

* * *

THE iron and steel industry seems to be almost capable of outracing the vision of its prophets. To one who notes the amazing swiftness of its rise, there must occur at times the fear expressed in these pages by Mr. J. S. Jeans, something more than four years ago—the fear of the "difficulty of finding adequate supplies of cheap and suitable iron ores." The figures which excited that fear in the mind of Mr. Jeans showed a total production of pig iron in the world reaching 37,300,000 tons in 1899. The summary just published in the statistical report of the American Iron and Steel Association gives the corresponding figures for 1903—only four years later, and a year of general though not severe depression—as 46,420,000 tons.

An increase of this magnitude is impressive enough ; it is nearly 25 per cent. in four years. The 9,000,000 tons we have added to our yearly manufacture since 1899 is a quantity greater than the total annual output of iron in the world forty years ago. But even more significant is the distribution of the present industry. Almost exactly half of the increase comes from the furnaces of the United States. Nearly a fourth is supplied by Germany. But Great Britain, once iron-master to the world, appears in the column of decrease. She has dropped to third place, furnishing but 18.98 per cent. of the total output, while Germany makes 21.73 per cent., and the United States 38.80—almost as much as England and Germany together.

Another extremely interesting movement shown by the estimates is the acceleration of the replacement of iron by steel as the great material of engineering construction. Twenty-five years ago, but one-fifth of the pig iron produced was converted into steel, or about 3,000,000 tons altogether in 1878. Fifteen years ago, the proportion made into steel had risen to nearly two-fifths of the total. In 1903 it was more than three-fourths—nearly 77 per cent. Undoubtedly the substitution of steel for iron has gone too far in some directions One of the movements to be expected within the next few years is the partial revival of the manufacture of soft iron. But of that we shall have more to say at another time.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

MOTOR-DRIVEN MACHINE TOOLS.

A DISCUSSION ON THE INDIVIDUAL OPERATION OF MACHINE TOOLS BY ELECTRIC MOTORS.

Journal of the Franklin Institute.

THERE has been so much said and written about the advantages and deficiencies of the electric motor for the direct driving of machine tools, that it has well been felt that the whole matter should be permitted to work out its own salvation, so to speak, at least to a limited extent, and permit constructors and users to profit by the lessons of experience.

At a recent meeting of the Franklin Institue there was recently held a discussion upon the use of electric motors for driving machine tools, and from a report of this discussion, in the *Journal* of the Institute, we abstract some of the leading points elicited.

The discussion was opened by Mr. Charles Day, who, after a brief historical review, showed that the use of independent electric driving represented at least 350,000 horse power in the United States alone, this being ample evidence of the extent to which various systems had come into use. Discussing the matter from the machine owner's viewpoint, Mr. Day said:

"Such factors as independent location of machines and better facilities for handling work are interesting, but are they worth while? In other words, is the constant-speed individual motor drive a paying investment? Ease of handling and speed control are terms that one constantly hears; but is the additional expenditure necessary to obtain them justified from a consideration of dollars and cents? Some concerns have gone ahead blindly, simply accepting the statement that the individual drive is the proper thing, and in almost every instance the resulting equipments do not begin to possess the possibilities that they should, and in many cases are not yielding a return to justify the expenditure.

"Until it is fully understood that the words 'a motor-driven tool' need not necessarily imply high efficiency, the advantages made possible by the use of the best types of such apparatus will not be gained. I feel that I cannot dwell too long or forcibly on this point. The tool steel, the machine, the motor, the man, are all but means to an end. Let us always first bear in mind this end. Machinery designed to fulfil the conditions of economical production is the machinery that will be purchased, not only once, but repeatedly, and that is what is needed to perpetuate this work. We can all point to large motor-driven equipments—usually the first installed; will they be duplicated or extended? Only if it can be clearly shown that a proper return has resulted. As stated above, a number of the largest equipments do not possess the possibilities anticipated; in others they may be present but of no earning value, on account of lack of intelligent direction of work. This is equally true of belt-driven machines; but the motor drive, with its greater possibilities, should only be adopted as the result of a definite need.

"The shop manager who does not see clearly the inability of a belted tool to attain maximum output, and the reasons, cannot hope to gain appreciably by purchasing a motor. Let me repeat, a motor-driven shop does not insure low cost of production any more than efficient guns can guarantee a naval victory."

Mr. Day compared the adaptation of electric motors to machine tools twelve years ago with recent examples, showing two lathes, originally designed for belt driving, but changed to be operated by electric motors. In the case of the earlier machine the motor ran at a uniform speed, the speed changes of the lathe being effected by a nest of gearing; in the second case the motor provided for a portion of the speed changes, these being extended by the use of gearing. Better results are obtained when the entire machine is designed for the use of electric driving, and undoubtedly this feature will be taken into account by machine-tool builders in the immediate future.

An important element for consideration is undoubtedly the choice between motors of uniform speed and variable-speed motors. The latter are the more expensive, both in installation and in operation, but until some entirely effective speed-varying device is put on the market it is probable that a portion of the speed changing will be done in the motor.

In continuing the discussion, Mr. F. B. Duncan said that it was desirable to take cognizance of the two great factors involved —the financial and the human.

"First, Does it pay?

"Second, How can we convince people that it does pay?

"The first question has been well threshed out, and while many foolish investments have been made in motor equipment (as foolish investments have ever been and will continue to be), yet, on the whole, electrically operated machine tools have paid well.

"Better placement of tools, especially the larger ones. The operation of powerful portable apparatus for use on the very largest work. Better crane service due to the absence of belts. The inestimable boon of the electric crane itself. Better light. Less dirt. Less danger to employees. Lighter overhead construction necessary in new factories due to non-existence of countershaft, etc. Fuel economy in many (but not all) instances; and last, and greatest of all, abundance of power to pull a cut of the most generous proportions at the highest speed permissible with the new high-speed tool steels."

The most important thing to be done at the present time is to impress upon tool builders that it is not sufficient to buy a motor and hitch it up to a tool originally designed to be driven by belting. What is needed is a complete re-design of present machine tools with motor operation alone in view, giving an entire line of machine tools designed electrically and mechanically for the production of the greatest amount of work in the shortest possible time.

"The tool builders and electrical men may well take a leaf from the experience of the automobile manufacturers. Until the latter abandoned standard motors, engines, bodies and gears, and evolved, appropriated and combined types made necessary by the exigencies of the case, no substantial progress was made; but since they have evolved new types of engines, motors, running gears, bodies, etc., the industry has advanced by leaps and bounds until it is one of the marvels of this wonderful century.

"The motor-driven machine tool will make a similar advance as soon as a firm is found with nerve enough to break away from old traditions, and put a few record-breaking tools on the market whose electrical and mechanical design is of the twentieth century.

"The requirements are simple and severe: machinery heavy and stiff enough to stand the maximum cut the work will stand, equipped with a motor designed to give the proper speed variation, and powerful enough to pull the maximum cut, built into the machine as an integral part of same.

"A few tools of this type set up alongside of belt-driven apparatus will soon convince the most skeptical that motor drive pays, for such machines will forge ahead of our present apparatus, much as a high-speed automobile distances a horse and buggy.

"We may also look forward to the time, not far ahead, when recording instruments on the tools will give the superintendent a check on production and on the individual operator, that will enable him to keep track of the 'personal equation' in the shape of lazy workmen in a most accurate and impartial manner, with corresponding benefits to the output of his tools, the dividends of the stockholders and the pay envelope of the diligent and intelligent mechanic."

Probably the judicial views of Professor Elihu Thomson upon this important subject may well be given, emphasising, as they do, the importance of the exercise of the careful judgment of the able engineer upon the merits of each case.

"My general opinion is that there is no hard-and-fast rule which can be laid down, everything depending on the conditions of use of the machine tools. In some cases the group drive will undoubtedly hold its own, and perhaps in other instances the belt, counter and line shaft will be retained. The individual drive is likely to continue to replace the older forms, particularly for the larger tools, and for those kept in active service at maximum output. The accumulation of data on the subject is gradually becoming such that it will be possible before long for competent engineers to determine the desirability or undesirability of resorting to individual operation by motors.

"A modern works of any extent now requires its engine-dynamo in power-house to be conveniently located, with connecting lines from which power is obtained from electric motors, sometimes to drive line shafting, serving groups of machines more or less extended, and at other times driving certain machines individually.

"The case of each factory or workshop is, it seems to me, one which needs to be considered by itself, with a careful estimation of all that goes to increase the economy of the operation."

LONG DISTANCE TRANSMISSIONS WITH CONTINUOUS CURRENTS.

THE POSSIBILITIES AND ADVANTAGES OF CONTINUOUS ELECTRIC CURRENTS AT HIGH VOLTAGES FOR POWER TRANSMISSION.

Le Génie Civil.

IN the course of the development of the application of electricity as a means of the transmission of energy, the necessity for employing high voltages soon appeared. One of the principal elements of cost is that of the metallic conductors, usually of copper, and it is only by the use of high pressures that the diameter of the line wire, and consequently the cost for material, can be kept within commercial limits.

Although, until recently, the continuous current has been principally used in electric motors, the alternating current, at high voltages has been employed for the line transmission, the transformation being made at the distributing stations by the use of rotary converters. With this arrangement pressures of 40,000 to 60,000 volts have been successfully employed, and in some cases, notably in California, distances of 150 to 200 miles are traversed by alternating currents transmitting as much as 40,000 kilowatts of electrical energy.

There are various drawbacks, however, to the use of alternating currents, the alternating action producing certain secondary phenomena, connected with capacity and inductance, tending to reduce the efficiency and the distance to which power can be satisfactorily transmitted. At high voltages also the striking distance of the current across the gap between the line wires, and the overcoming of the resistance of insulators constitute certain limits to the employment of the still higher voltages which might otherwise be desirable.

For these reasons it has been thought possible that a return to the continuous current might be a subject for consideration, and hence a number of experiments which have recently been made by the Compagnie de l'Industrie Electrique, of Geneva, are of immediate interest. From an account in a recent issue of *Le Génie Civil* we make some abstract of these investigations, which are probably but the first of other more extended researches.

At the present time the continuous current is not employed in actual service at pressures higher than 25,000 volts. Experience has shown that with the continuous current, using a line of 30 kilogrammes of copper per electrical horse power at the terminus, and allowing a loss 10 per cent., a pressure of 42,000 volts is required for a distance of 100 kilometres, or a little more than 62 miles. Unless, therefore, such voltages can be commercially produced and maintained the continuous current is not available, and it is certain that the demand is for transmissions of greater length than 60 miles, rather than for shorter ones.

Although continuous-current generators of the Thury type may be constructed to generate currents of high voltages by the introduction of condensers between the sections of the armature, the experiments at Geneva were made by connecting three dynamos in series, a pressure of 70,000 volts being thus readily attained. The current generated being 1 ampere, a power of about 70 kilowatts could be developed, and comparative trials were made under these conditions with an alternator of 75 kilowatts, and a frequency of 50 cycles, to ascertain the relative losses. These trials were made to determine the distances at which discharges through air took place, the insulating resistances of various line insulators of accepted design, and the behaviour of various insulating materials.

So far as the sparking distances are concerned, these naturally depended much upon the nature of the terminals, and experiments were made with terminals consisting of points, balls, and plates in various combinations. The distances, while irregular, were in all cases much greater for the alternating than for the continuous current, the ratio being from 1.5 to 2 times greater. It follows that line wires for use with continuous currents may be placed nearer together with less liability of discharges than is the case with the alternating current.

The most important portion of the trials appeared in connection with the behaviour of insulators. These were made upon a number of commercial forms of porcelain insulators, mounted as for regular service, and tested, both in the laboratory and during a fine rain in the open air. The results are given in tabulated form, with drawings showing the construction of the various insulators, and some very interesting conclusions appear. In all cases the insulation is far better maintained with the continuous than with the alternating current. Broadly, the insulators were found to stand about double the voltage with the continuous current than with the alternating, and in the former case there was little or no crackling or brush discharges until the limiting voltage was almost reached.

With the alternating current, on the contrary, there was evident loss by discharges as the breaking-down pressure was approached, and a corresponding noise. In nearly all cases the insulation failed by discharge taking place between the wire and the pin support, without perforating the porcelain. With the best types of multiple petticoat insulators, pressures of 60,000 volts and over were sustained without difficulty.

Some experiments were also made upon various insulating materials, and in every case the greater resistance to the continuous current appeared, so that there is little doubt that, so far as insulation is concerned, the line losses by leakage may be materially reduced by the substitution of the continuous for the alternating current.

It has been maintained that with the continuous current an electrolytic action takes place, and that this will lead to a gradual disintegration of the material of the insulator, or at least such changes as will materially diminish its insulating properties. It has been found, however, that this action cannot take place except in the presence of free moisture in the body of the material, a condition which it is entirely possible to prevent, and which, indeed, cannot exist in such materials as porcelain, mica, etc. In the case of the electrical machinery itself, the moderate heat which appears in dynamos, motors, etc., effectually prevents the accumulation of moisture.

The general conclusions which may be drawn from these experiments are, that it is entirely possible to use the continuous current at voltages sufficiently high to enable it to compete with the alternating current for long-distance power transmission, and that by the use of the direct current many of the phenomena which limit the commercial uses of the alternating may be altogether avoided. When it is understood that the continuous current at 22,000 volts pressure is even now successfully used in transmitting 5,000 horse power between St. Maurice and Lausanne, a distance of 60 kilometres, it will be seen that there is encouragement for extending both the voltage and the distance. It is to be hoped that additional experiments will be made and that this important subject may be further developed.

RAPID TOOL-STEELS.

RECENT DEVELOPMENTS IN THE MANUFACTURE AND APPLICATIONS OF HIGH-SPEED TOOL STEELS.

J. M. Gledhill—Iron and Steel Institute.

SEVERAL months ago we reviewed in these pages a paper by Mr. Gledhill, presented before the Coventry Engineering Society upon modern rapid-cutting steels, and now we have a fuller and later treatment of the same subject by the same author in the form of a paper presented at the New York Meeting of the Iron and Steel Institute.

Mr. Gledhill, while speaking mainly for the steel made by Sir W. G. Armstrong, Whitworth & Co., discusses the subject broadly, and without limiting himself to any proprietary matters. He briefly reviews the development of high-speed steels, and calls attention to the interesting fact that the "wootz" of India, and the famous Damascus steels, are known to have contained tungsten, so that a latent high-speed steel may be said to have existed centuries ago, and only a knowledge of the proper method of tempering it was lacking.

The most interesting portion of Mr. Gledhill's paper is the summary of the results of experiments with steels of various compositions, these showing practically how the best modern high-speed steels are made.

The high-speed steels of the present day are combinations of iron and carbon with—

(1) Tungsten and chromium,
(2) Molybdenum and chromium,
(3) Tungsten, molybdenum and chromium.

These present many interesting varieties, and offer a wide field for research. The author has made a large number of experiments to ascertain comparative cutting powers of steels produced by varying proportions of these elements, and it may be interesting to briefly state the results of some of those investigations.

Influence of Carbon.—A number of steels were made with the carbon percentage varying from 0.4 per cent. to 2.2 per cent., and the method of hardening was to heat the steel to the highest possible temperature without destroying the cutting edge, and then rapidly cooling in a strong air blast. By this simple method of hardening it was found that the greatest cutting efficiency is obtained where the carbon ranges from 0.4 per cent. to 0.9 per cent., and such steels are comparatively tough. Higher percentages are not desirable because great difficulty is experienced in forging the steels, and the tools are inferior. With increasing carbon contents the steel is also very brittle, and has a tendency to break with unequal and intermittent cutting.

Influence of Chromium.—Having thus found the best carbon content to range from 0.4 per cent. to 0.9 per cent., the next experiments were made to ascertain the influence of chromium varying from 1.0 per cent. to 6.0 per cent. Steels containing a low percentage are very tough, and perform excellent work on the softer varieties of steel and cast-iron, but when tried on harder materials the results obtained were not so efficient. With an increased content of chromium the nature of the steel becomes much harder, and greater cutting efficiency is obtained on hard materials. It was observed with an increase of chromium there must be a decrease in carbon to obtain the best results for such percentage of chromium.

Mention may here be made of an interesting experiment to ascertain what effect would be produced in a rapid steel by substituting vanadium for chromium. The amount of vanadium present was 2.0 per cent. The steel readily forged, worked very tough, and was hardened by heating to a white heat and cooling in an air blast. This tool when tried on medium steel stood well, but not better than the steel with the much cheaper element of chromium in it.

Influence of Tungsten.—This important element is contained in by far the greater number of the present high-speed steels in use. A number of experiments were made with the tungsten content ranging from 9.0 per cent. to 27.0 per cent. From 9.0 per cent. to 16.0 per cent. the nature of the steel becomes very brittle, but at the same time the cutting efficiency is greatly increased, and about 16.0 per cent. appeared to be the limit, as no better results were obtained by increasing the tungsten beyond this figure. Between 18.0 per cent. and 27.0 per cent. it was found that the nature of the steel altered somewhat, and, instead of being brittle, it became softer and tougher, and while such tools have the property of cutting very cleanly, they do not stand up so well.

Influence of Molybdenum.—The influence of this element at the present time is under investigation, and our experiments with it have so far produced excellent results, and it is found that where a large percentage of tungsten is necessary to make a good rapid steel, a considerably less percentage of molybdenum will suffice. A peculiarity of these molybdenum steels is that in order to obtain the greatest efficiency they do not require such a high temperature in hardening as do the tungsten steels, and if the temperature is increased above 1000° C. the tools are inferior, and the life shortened.

Influence of Tungsten with Molybdenum.—It was found that the presence of from 0.5 per cent. to 3.0 per cent. molybdenum in a high tungsten steel slightly increased the cutting efficiency, but the advantage gained is altogether out of proportion to the cost of the added molybdenum.

Influence of Silicon.—A number of rapid steels were made with silicon content varying from a trace up to 4.0 per cent. Silicon sensibly hardens such steels, and the cutting efficiency on hard materials is increased by additions up to 3.0 per cent. By increasing the silicon above 3.0 per cent., however, the cutting effect begins to decline. Various experiments were made with other metals as alloys, but the results obtained were not sufficiently good by comparison with the above to call for comment.

The composition of the "A. W." steel, as given by Mr. Gledhill, may be of interest, this containing 0.55 per cent. of carbon, 3.5 per cent. chromium, and 13.5 per cent. tungsten.

The difference in the behaviour of carbon and high-speed steel is both interesting and curious. An ordinary carbon steel of 1.20 carbon, when heated and quenched, becomes exceedingly hard, but loses this hardness with the increase in the temperature of friction in use, this limiting definitely the speed at which it may be used. The high-speed steel, having been raised almost to the melting point in hardening, can withstand correspondingly high friction temperatures before sensibly losing its hardness.

The theory of this fact, according to Le Chatelier and Osmond, is involved in that of the temperature of transformation.

"Steel undergoes at 700° C. a change of nature which has been studied in all its details by M. Osmond. This transformation, like a great number of chemical transformations, takes place with more or less considerable delay according to certain other circumstances. *When heating,* the transformation will take place above 700° C.—for example, from 750° to 800° C., according to the rapidity of heating. *When cooling,* below 700° C. the quickness with which this transformation takes place at a given temperature, is governed by a general law of chemical phenomena, and this rapidity is so much the greater (1) As the absolute temperature in question is highest; (2) As it is at its greatest distance from the point of transformation."

The influence of tungsten, chromium, molybdenum, and other elements is to retard the transformation at the critical point, as compared with ordinary carbon steels.

In preparing the high-speed steel for use, Mr. Gledhill calls attention to the importance of annealing it thoroughly before working into bars, this relieving all internal strains, and rendering it sufficiently soft for machining into shape, as for milling tools, drills, taps, etc.

The necessity of heating the tool to a high temperature, in order to harden it, has given rise to various plans for accomplishing this operation under satisfactory control. Mr. Gledhill describes various methods, including the use of muffle furnaces, gas stoves, and ordinary shop methods, but evidently prefers the use of electricity as most convenient and controllable. One method consists in the use of a solution of potassium carbonate, the tank and the tool forming portions of an electric circuit which is completeed when the tool is dipped in the solution. The passage of the current sets up an intense heat on the immersed part of the tool, and the switching off of the current permits rapid cooling without removal from the solution.

The electric arc has also been used for

heating the tool, this being especially useful for the production of local heating at desired points. Electric heating has been found most useful for annealing certain portions of high-speed steel tools, enabling the interior of milling cutters, gear cutters, hollow taps, or reamers, and the like, to be made soft and tenacious without impairing the cutting qualities of the exterior.

Mr. Gledhill gives some interesting examples of the gains effected by the use of high-speed steel, showing a gain of five to one in turning armor-plate bolts, not including the saving due to the possibility of making the bolts from the round bar instead of requiring expensive forgings. Other examples are given, but the operative gains from the use of modern steels are now so well known that it is almost unnecessary to mention them. One illustration may be given, however, as remarkable, namely, the milling of large hexagonal nuts for armor-plate bolts, these nuts, for 3⅜ bolts, being produced so economically that the cost of making 12 such nuts is less than the cost of forging one nut under the old method.

IMPROVEMENTS IN BLAST FURNACE PRACTICE.

PRACTICAL RESULTS IN THE APPLICATION OF THE DRY-AIR BLAST TO THE MANUFACTURE OF IRON.

James Gayley—Iron and Steel Institute.

NOTWITHSTANDING the advances which have been made in recent years in the manufacture of steel and its resultant products there has not, until very recently, been a corresponding progress in the method of making the raw material of the steel furnace, the pig iron which is the first stage in the treatment of the ore in the blast furnace.

At the last meeting of the Iron and Steel Institute there was presented an important paper by Mr. James Gayley, giving an account of practical results in the increase of the efficiency of the blast furnace by a method which had until then been almost neglected.

This point, to which Mr. Gayley has directed his attention, is the question of the influence of the contained moisture in the air upon the action of the furnace, a matter which appears to be well worthy of the close attention and experiment of all manufacturers of pig iron. As Mr. Gayley points out, the closest effort has been given to securing uniformity in the various elements of the charge, while all the time there has been a far greater variation in the constitution of the air forming the blast than with any other material entering the furnace.

"Great and important improvements have been made in the blast-furnace and its accessories, as in the hot-blast stoves, the increase in size and change in the shape of the furnace, more efficient blowing-engines, the increased protection given to the bosh walls, and in the careful preparation of the raw material, all of which have exerted a pronounced influence on the further operations from a metallurgical standpoint. During the past eight years but little advance has been made in this direction; the fuel consumption has not diminished, nor has there been any material increase in production. Within this period, however, there has been witnessed the greatest development in appliances for the economical handling of material, and so complete has been the work in this direction, that, except in isolated cases, in this country at least, a further extension does not hold out much promise of a satisfactory return on the investment required. It seemed that, with the exception of the gas-engine, we had about reached the limit, for like a strong wall the atmosphere, with its humidity as variable to-day as when first blown into a primitive blast-furnace, appeared to stand as a barrier to further progress. In furnaces using ore from the Lake Superior district the raw material, amounting to about 7,200 pounds per ton of iron, varies in composition within 10 per cent. and is as uniform as human skill can make it; but the atmosphere, of which 11,700 pounds are consumed per ton of iron, varies in its content of moisture from 20 to 100 per cent., from day to day and often in the same day, thus rendering the process, even with the best appliances, an uncertain one and dependent on the caprice of the atmosphere."

The deteriorating influence of moisture in the blast furnace is well understood by managers, since the leakage of water from a tuyere is known to be followed by a serious chilling effect, but few realize the quantity of moisture which is introduced with the air under ordinary atmospheric conditions. Mr. Gayley computes that the presence of one grain of water per cubic foot of air corresponds to about one gallon of water per hour for each 1,000 cubic feet used per minute, while meteorological records show that in the vicinity of Pittsburg the quantity of moisture in the air ranges from 3 to 7 grains per cubic foot, according to the season.

"By simply multiplying the grains of moisture by 40—which represents the number of gallons of water entering a modern furnace per hour, for a content of 1 grain of moisture in a cubic foot of air—a clear idea can be had of the gallons of water entering the furnace per hour, for the various conditions of humidity. The changes are great not only from day to day, but from hour to hour in the same day, and often they are very abrupt. These records were made at a furnace plant, located on the bank of a river, where the conditions exist for an increase in humidity as compared with higher ground; and to what extent the abrupt changes may have been caused by the presence of steam in the atmosphere—absorbed from spraying of the hot pig beds, the blow-off from boilers and exhaust from engines, or from a rainstorm, when the humidity decreases suddenly—it is impossible to say. How frequently has it happened in the experience of every furnace manager, that the furnace has gradually or suddenly lost its hearth temperature and produced a grade of iron either undesirable or unmarketable, without any visible cause. Tuyeres are examined for leaks, the raw material in the stockyard is carefully inspected, and usually the coke is condemned. A more intimate acquaintance with the atmosphere would have provided a correct and ready reason, for the variations therein are not only many times greater than in the raw material, but a greater weight of it is used per ton of iron."

In view of these facts it became evident that experiments with dry air might result in a material improvement in blast-furnace performance, and hence various schemes were investigated with a view of determining upon the most feasible for practical use. It was finally decided to remove the moisture from the air by means of cold, the moisture being deposited upon the coils of a refrigerating machine, leaving the air practically dry. By constructing an experimental chamber containing coils connected with an anhydrous ammonia refrigerating machine, and using steam to charge the air to any determinate degree of moisture, data were obtained for use in designing an operative plant.

This operative plant has been built for use with the Isabella furnace, near Pittsburg, and the details of the apparatus are very fully shown in the paper of Mr. Gayley. The apparatus does not differ materially from a standard refrigerating plant, using anhydrous ammonia in connection with a brine tank and circulating coils. The plant has a capacity corresponding to the melting of 225 tons of ice, for one compressor, there being a reserve machine of equal capacity. The cooling coils for the air contain 90,000 lineal feet of 2-inch pipe, so arranged as to distribute the incoming air over the whole surface, the moisture being deposited in the form of frost.

This plant has been in operation since August 11, of the current year, and it has fully demonstrated the value of the system. The ore burden for 10,200 pounds of coke has been increased from 20,000 pounds of ore to 24,000 pounds, a gain of 20 per cent., while the reduced load on the blowing engines, due to the reduced volume of the cold air, fully makes up for the power required for the compressor.

"The application of the dry-blast to the blast-furnace has shown, in addition to the economies effected, that the furnace can be operated with precision; it works with greater regularity, and in consequence the product is uniform with respect to grade and composition, which makes the dry-blast of particular value in the making of foundry iron, which is marketed by grade. An increase or decrease in blast temperature has a definite effect and can be relied on to accomplish the desired result.

"The dry-blast plant since it was started on August 11 has been in regular operation. It started without a hitch and no difficulties have developed in any direction. Some modification in construction has been indicated as the result of the operation of the plant which would further reduce the moisture and add to its uniformity, but so far the changes suggested have been slight.

"While the application of the dry-blast to the blast-furnace has effected various economies and produced a more uniform metal, its further application to the Bessemer converter would no doubt result in great benefit, since air is used in large quantities and the varying humidity affects the temperature of the charge and in consequence the quality of the steel. The metal from the metal-mixer is remarkably uniform and the additional uniformity secured through the use of dry air would be of further advantage. It happens that a higher silicon is required in he summer months to maintain the temperature of the blow, in which period it is also more expensive to maintain the right amount of silicon in the pig-iron. With the use of the dry-blast in the converter the proper temperature could be secured with a lower silicon in the metal, and this in turn would further reduce the coke consumption at the furnaces. In other processes where air is used in large quantities—particularly in smelters and copper converters and in the open-hearth furnace and in cupolas—it would appear that the use of dry-air would effect important economies.

MODERN MASONRY ARCHES.

IMPROVEMENTS IN DESIGNS AND CONSTRUCTION WITH A VIEW OF SECURING A BETTER UTILIZATION OF THE MATERIAL.

M. Séjourné—Révue Générale des Chemins de Fer.

WHILE the arch is one of the oldest forms of construction for spanning an opening it has been improved but slowly, and even to-day there is room for modifications which shall add to its stability and efficiency. This is especially the case with arches of large span, and the increasing use of masonry bridges in the place of steel structures has called attention to the room for improvement.

In a paper recently contributed to the *Révue Générale des Chemins de Fer,* by M. Séjourné, the economical construction of large masonry arch bridges is discussed, and the conditions leading to efficiency are shown.

As is well known, the dead load constitutes by far the greater portion of the weight supported by an arch of masonry, the live load forming such a small proportion as to be almost negligible for large structures. Since the carrying of the live load is the real object for which a bridge is built, it is evident that the efficient use of the material is measured by the proportion of dead to live load, and that any method of diminishing the amount of material used in an arch of given span and width will conduce to an increased efficiency.

There appears to be no way of reducing the dimensions of a given arch in a manner which will give an increased efficiency to the material under the ordinary methods of construction. The depth at the key and at the springings, and indeed the general dimensions of the arch ring cannot be controlled entirely by the considerations deduced from the computed pressures, since the position of the curve of pressure is, to a certain extent, indeterminate, and the ring must be made sufficiently deep to include the curve of pressure beyond any reasonable doubt. There are also aesthetic considerations which cannot be ignored, and when all these are taken into account the proportions of an arch of given rise, span, and loading are closely limited.

Another method of economizing material, however, has been devised and successfully executed in a recent important structure, and it is also to be employed for another large bridge of recent design. This method is the employment of two narrow arch rings, with a flat connecting flooring to carry the moving load. We have already referred to the employment of this plan in the construction of the great Luxembourg arch of 84.65 metres (277.73 feet) span, and details of this great structure are given and illustrated in the paper of M. Séjourné. In the case of the Luxembourg bridge the total clear width of the bridge is 16 metres, and each of the arch rings is made 5.25 metres wide. There are thus two separate arches, placed side by side, and identical in every respect, with a space of 6 metres between the two arches, this being covered at the roadway level by a flooring in reinforced concrete.

This arrangement possesses several advantages. In the first place fully one-third of the masonry is dispensed with, and this includes the most expensive kind of masonry, being the cut stone voussoirs of the arch ring. In the second place it permits a single centering being used for both arches, and in the case of arches of large span the saving in large and heavy timbers is an important element in the expenditure. In the case of the Luxembourg arch a centreing was made for the single arch, and after this had been used for one ring it was shifted laterally until it was in position for the second ring, and the cost of this movement was much less than would have been necessary for the construction of a centreing for the full width of the whole bridge.

The flooring which spans the space between the two arches is readily made capable of sustaining that portion of the moving load which comes upon it, and in this respect it is not greatly different from the flooring of an ordinary truss bridge, which is sustained entirely by the spans on each side. In the case of the Luxembourg arch the total cost was 1,500,000 francs, and it is estimated that fully 500,000 francs was saved by the adoption of the double arch design.

The satisfactory result obtained at Luxembourg has doubtless influenced M. Résal to advocate the use of the same principle in the case of the new bridge to be built over the Garonne at Toulouse.

The bridge is to have five elliptical arches, of spans of 46, 42, and 38.5 metres, with a rise of about one-fourth the span in each case, and it is intended to make the arches in pairs of 3.25 metres in width, with a space of 9.5 metres between them. The width of the roadway will be 13.2 metres, and the sidewalks 4.4 metres, these latter partially overhanging the arches. By adopting this form of construction a bridge of 16 metres in width is obtained by constructing two sets of arches of 3.25 metres width each, the centreing being used twice for each arch. The result of the adoption of this plan is a saving of 300,000 francs, while the effectiveness of the whole is not diminished in the slightest.

The successful demonstration of the feasibility of this method of constructing masonry arch bridges should lead to its general adoption, especially for large spans in which the saving is proportionally greater, and there is every reason to believe that the plan originally adopted for the great Luxembourg arch will come into general use.

GAS, OIL, AND STEAM ENGINES.

THE RELATIVE ECONOMY ATTAINED BY INTERNAL-COMBUSTION AND STEAM ENGINES IN THE GENERATION OF POWER.

Michael Longridge—The Engineer.

THE question of the production of motive power from combustible materials is one which has been discussed by many able engineers, but the constantly changing phases of the problem make it always of interest and value. This is especially the case since the development of the different forms of internal-combustion motors has broadened the subject and extended it so as to include other engines than those operated by the vapor of water. In an interesting address, delivered by Mr. Michael Longridge before the British Association of Managers of Textile Works at Manchester, and published in the *Engineer*, the relative advantages of gas, oil, and steam for power generation are examined in a very clear and interesting manner, and we make some abstract of his paper.

For the purposes of comparison between the three types, Mr. Longridge takes the following rates of fuel consumption:

A steam consumption of 11.1 pounds per indicated horse-power-hour,

A gas consumption of 82.4 cubic feet per horse-power-hour, and

An oil consumption of 0.334 pounds per horse-power-hour.

These are not record figures, but represent what has been done by the three types respectively in good modern practice. They will not suffice, however, to enable the engines to be compared without additional information. It is necessary to compare them in units of the same kind. This may be done by reducing these several fuel consumptions into British thermal units, taking into account the calorific power of the gas and oil, as well as the number of heat units contained in the steam, and upon this basis the heat consumption of the three engines work out, per indicated horse-power-hour: steam engine, 13,011 B. T. U.; gas engine, 8,817 B. T. U.; and oil engine, 5,930 B. T. U. From the fact that one horse-power-hour represents 2,562 B. T. U. it is readily seen that the steam engine has an efficiency of 19.65 per cent., the gas engine, 29.1 per cent., and the oil engine the high efficiency of 41 per cent.

Mr. Longridge proceeds to show that no heat engine can be expected to return 100 per cent. of the heat supplied to it, because of the limited temperature range through which it can be operated. Instead of proving this by mathematical demonstration, he uses the excellent simile of the utilisation of a fall of water, showing that it is not the total head of water which is to be considered, but only the difference of level actually existing between the upper level and the position of the wheel. Applying this principle to the temperature differences in the several cases under consideration, it appears that the steam engine could not convert more than 38 per cent. of the heat supplied to it into work; while the highest possible efficiencies of the gas and oil engines would be 74 and 84 per cent. These latter efficiencies must be considered merely as approximations, since the maximum temperatures in the cylinders of internal-combustion engines have not yet been precisely determined.

Mr. Longridge proceeds to discuss the Carnot cycle in connection with the possible development of heat engines, showing that while the maximum theoretical efficiencies cannot be wholly realized, they may be approached more closely by the use of this cycle than by any other action. On the pressure-volume diagram the Carnot cycle is represented by four curves, two being adiabatics and two isothermals. On the temperature-entropy diagram, the Carnot cycle appears as a rectangle, the isothermals being horizontal lines, and the adiabatics, verticals.

The impossibility of realizing the Carnot cycle in a steam engine is evident when it is understood that it requires the absence of clearance and of cylinder condensation, and demands that there should be neither absorption or giving out of heat by the cylinder walls.

The nearest approach to the Carnot cycle which can be expected in a steam engine is one in which the final adiabatic compression is omitted, and from computations based upon the equations of Rankine, Mr. Longridge gives the various maximum efficiencies for saturated and for superheated steam, at several pressures, taking the superheating at the maximum practicable temperature of 800° F. At 200 pounds pressure, with saturated steam this gives a possible efficiency of 30.3 per cent., and with steam superheated 800°, an efficiency of 33.1 per cent.

"The sources of waste which interfere with the attainment of these standards are:—

"First, radiation, which may be rendered unimportant by careful covering of pipes and cylinders.

"Secondly, wire-drawing, which, unless the fall in pressure is very great, is not of serious consequence except when it occurs between the cylinder and the condenser. A certain amount of wire-drawing between the stop valve and the piston may even be beneficial. for, since no heat is lost, the drop in pressure is utilized in evaporating moisture or in superheating the steam, if it be already dry. The remedy is large passages and ports, but it must always be remembered that large ports mean large clearance spaces, and what is more detrimental still, large clearance surfaces.

"Thirdly, cylinder condensation. The cylinder metal cooled by the previous exhaust stroke absorbs heat from the incoming steam, condensing part of it during the admission and early part of the expansion, and gives out this heat again during the later part of the expansion and exhaust, thus breaking Carnot's laws that all heat must be supplied at the highest temperature, that the expansion must be adiabatic, and that all the heat must be rejected at the lowest temperature. This is a very important source of loss, especially in reciprocating engines. In turbines it is not so great, because the steam enters at one end and passes out at the other. Thus the hottest steam does not come in contact with the coldest metal. The remedies are multiplication of cylinders to reduce the range of temperature in each; steam jacketing for slow revolution engines; and superheating, if possible, to such an extent as to keep the steam dry throughout the stroke.

"Fourthly, leakage past valves and pistons. This may also be important. The remedies are—the adoption of shapes least subject to distortion by heat and pressure; accurate and highly finished workmanship, and superheating. You know the velocity of a fluid flowing through an orifice, such as must exist between a valve and its seating if there be leakage, is proportional to the square root of the pressure forcing the fluid through; consequently the weight of fluid forced through in a given time depends upon its density; therefore, as water is 500 or 600 times denser than superheated steam, the leakage will be 500 or 600 times greater when the steam is wet than when it is dried by superheating.

"Fifthly, incomplete expansion. The figures relating to the standard engine are calculated on the supposition that the expansion is continued till the pressure falls to that in the condenser. Practically, it will not pay us to expand to so low a pressure. First, because the cylinder required would be so enormous. Secondly, because a pressure less than that required to drive the engine itself is no use to us."

Mr. Longridge shows also that the attainment of the Carnot cycle is impossible with the gas engine.

"The isothermal combustion of the gas, the expansion without loss of heat, the sequence of isothermal and adiabatic compression, alone present insuperable difficulties, and gas engine makers have not made the attempt to overcome them. They have chosen an entirely different mode of action. Gas and air mixed together and compressed into the clearance space are fired by a gas flame or electric spark; the combustion is accompanied by a rapid rise of temperature and pressure; the heated gases expand, driving the piston forward; at the end of the stroke they escape into the air; a fresh charge of air and gas is drawn in, compressed into the clearance space, and fired. In some cases the cycle is completed in four strokes, in others in two. In all engines the cylinders, and in large engines the pistons and the piston-rods, if there are any, are cooled by water, which carries off large quantities of heat."

According to computations by Mr. Dugald Clerk, the maximum efficiency attainable by the gas engine is about 45 per cent., and in practice only about 57 per cent. of this is actually attained, owing to unavoidable losses with the exhaust and in the cooling water.

In the case of the oil engine, the only attempt to approach the Carnot cycle is made in the Diesel motor, and theoretically this offers a very close approach to the most efficient cycle.

"The ideal Diesel engine is a very near approach to Carnot's perfect heat engine. Its characteristics are:—

"(1) Production of the highest temperature of the cycle, not by or during combustion, but before and independently of it, solely by compression of air.

"(2) Gradual introduction of the combustible into the compressed and heated air during the first part of the stroke in such a way that the heat produced just keeps pace with the work done by the piston, so that the combustion is isothermal.

"(3) The use of charge of air proportional to the heating value of the combustible, and sufficient to keep the cylinder temperatures within such limits that the working of the engine and its lubrication may be carried on without any water jackets. Its thermal efficiency is almost the same as that of Carnot's perfect heat engine.

"Practically, this ideal has not yet been realised, but it is so high that even the distant approach to it which has been made is in advance of the economy of any other engine.

"The actual cycle adopted as a compromise between theoretical and practical requirements is:—

"(1) Outward stroke; Admission of air at atmospheric pressure.

"(2) Inward stroke: Compression of air to about 500 lb. per square inch and 1,000° F.

"(3) Outward stroke: gradual admission and combustion of oil, followed by expansion.

"(4) Inward stroke: Expulsion of waste gases.

"The indicator diagrams are similar in appearance to those taken from a non-condensing steam engine working with a high pressure, early cut-off, and high compression."

Theoretically, the Diesel motor as constructed, should give a maximum efficiency of 67 per cent., and tests show that about 63 per cent. of this is actually attained.

Although most conservative in his conclusions, Mr. Longridge does not hesitate to say that he believes that before long the more economical forms of internal-combustion engines will become formidable rivals to the steam engine for factory driving, and may ultimately supplant it.

ARTIFICIAL VENTILATION ON SHIPBOARD.

EXPERIMENTAL INVESTIGATIONS WITH VENTILATING FANS ON VESSELS OF THE UNITED STATES NAVY.

Naval Constructor D. W. Taylor, U. S. N.—Engineering News.

AMONG the problems involved in the equipment of a modern ship of war must be included that of adequate ventilation. On the great passenger liners this is naturally an important matter, but it also demands consideration on a battleship or cruiser, especially since these latter are often sent for duty in the tropics, and in any case must be the residences of their occupants for comparatively long periods of time.

Some of the recent experiments which have been made in vessels of the United States Navy are discussed in a paper by Naval Constructor D. W. Taylor, published in a recent issue of *Engineering News,* and some review of the principal points is given.

Rotary fans attached to pipe systems for forced or mechanical ventilation were first fitted on United States vessels by Ericsson on his monitors. They have figured more or less on our naval vessels ever since, even upon the wooden vessels built in the seventies. Until about seven years ago steam fans were used. The earliest vessel to have a complete outfit of electric fans was the "Nashville," first commissioned in 1897. For five years or more all ventilating fans have been electrically driven. In the earlier vessels of the new Navy, built between 1885 and 1890, it was customary to fit a few large steam fans for ventilating living spaces, and these were so fitted with a system of flap valves that they could be used either as supply or exhaust fans. When such a system, after being run exhausting for some time, was changed to supply air, it blew into the living spaces an astonishing amount of dust which had accumulated in the pipes. At present, while both supply and exhaust systems are fitted, the tendency is to rely mainly on the former and use the latter only for such places as lavatories, water closets, dynamo rooms, steering engine rooms, etc. Probably under conditions on shipboard a supply system requires less power to move a given quantity of air. A distinct advantage is that with single piping fresh air is supplied positively. With an exhaust system the air which takes the place of that exhausted is not necessarily fresh, unless supply pipes are fitted as well as exhaust. The principal practical objection to a supply system of ventilation is that in cold weather it is very difficult to avoid unpleasant draughts from it, and it is apt to be shut off. In the tropics, however, where ventilation is most needed, the cooling currents from a supply system are found grateful and pleasant.

At present, using electric power, a great many more fans are fitted than was customary when steam was used. There are advantages in using a number of separate fans. The piping is simpler and fewer holes in watertight decks and bulkheads are required. But with steam power the use of a number of small fans would involve a network of steam and exhaust pipes which could not be considered for a moment.

Mr. Taylor describes especially the experiments which have been made on the battleship Missouri, this being a typical example of the ventilating plants on the later battleships, and the extent of this department will be realized when it is understood that on this vessel there are 32 fans, requiring motors aggregating 87 horse power for their operation.

The solution of the problem of supplying a compartment or number of compartments on a ship with fresh air requires the solution of two interdependent problems, which may be stated as below:

(1) Given a properly designed system of piping and outlets, with what maintained pressure at the fan outlet will this system deliver the required quantity of air?

(2) What fan will deliver at its outlet the required quantity of air and maintain the required pressure with the minimum expenditure of power?

The experiments made have dealt mainly with the second problem. It was determined in the beginning to obtain results from the fans when working under conditions practically the same as when in service on board ship. This required that each fan should discharge against pressure into a pipe somewhere near the size of its outlet and that the pressure in the pipe and velocity of the air should be determined simultaneously with the actual power being delivered to the fan.

Mr. Taylor describes in detail the tests made upon selected fans operated by special electric motors through a spring torsion dynamometer, the air velocities and pressures being measured with a special form of Pitot tube. A number of such tests were made at the Model Basin at the Washington Navy Yard, and from the results thus obtained the corresponding characteristic curves for several fans were plotted. From the formulas deduced from the laws of similitude these results may be applied to similar fans of other dimensions and speeds. The value of these experiments, therefore, extends beyond their immediate application, and they form an acceptable contribution to an important department of applied science.

Among the experiments may be noted also those to determine the pressure required in a pipe to maintain a certain discharge. This involves the determination of the friction of air in plain cylindrical pipes. The method employed was that of measuring the velocity and pressure of air at two different points on the same pipe, the points being separated by a distance sufficiently great to enable reliable quantitative results to be secured.

The following conclusions were deduced from the experiments:

(1) The coefficient of friction does not change with the velocity of the air for velocities up to 6,000 ft. per minute.

(2) The coefficient of friction does not change with size of pipe, at least up to sizes three or four square feet in sectional area.

(3) The friction varies at the squares of the velocity of air through the pipe.

(4) The coefficient of friction for pipes of the best workmanship in the best condition is as low as .00008.

The paper of Mr. Taylor forms a most useful contribution to this important department of work, and it will be found of service not only for marine work, but also in connection with stationary installations.

INTERNAL TRANSPORT IN THE UNITED STATES.

THE DEVELOPMENT OF MERCHANDISE TRAFFIC ON IMPROVED WATERWAYS AND RAILROADS IN AMERICA.

E. P. North—American Society of Civil Engineers.

AMONG the valuable papers presented at the Engineering Congress held by the American Society of Civil Engineers at St. Louis we note one by Mr. E. P. North, treating of the development of internal transportation of merchandise in the United States, from which some extracts are given.

"In one great source of national wealth, cost of transportation, which is not a natural product, the United States has an undisputed advantage over all other countries. Shortly before his death, Mulhall said that the average rate received by railroads of different countries for transporting a ton of freight one mile was, reduced to cents: United Kingdom, 2.80; Italy, 2.50; Russia, 2.40; France, 2.20; Germany, 1.64; Belgium, 1.60; Holland, 1.56; United States, 0.8. These figures show that the low cost of internal transportation has been the principal cause of its augmented wealth; an augmentation that was greater in the decade ending with 1900 than during the 80 years preceding 1870. For not only does a low freight rate allow more to be divided between producer and consumer, but it has a more potent effect in inviting the production of commodities which with higher freight charges could not reach consumers; thus adding greatly to the employment offered to labor and capital."

Comparing the tabulated result from Poor's Manual, Mr. North showed that the ton-miles per annum increased 2.5 times from 1885 to 1902, while the earnings nearly doubled, and the maximum freight rate tell from 1.057 cents to 0.764 cent.

"If the rates had remained as in 1885 there would have been paid $3,500,000,000 more for transporting our freight than was the case, and if American freight rates had been equal to those of England, as stated by Mulhall, and with as large a volume of business possible at such rates, the cost would have been nearly $33,000,000,000 greater, or more than the increase in wealth during the last decade. American railroad freight rates are the lowest in the world, and this is probably true also of coastwise freight rates. The low cost of assembling and distributing commodities has also had an important influence on their production and consumption.

"It is noticeable that this distinctive position as transporters has been reached with the highest wages paid for labor known and until lately with a higher cost for materials than those of neighbors and competitors. But both the high wages and high prices have, by stimulating production and consumption, added to the volume of freight moved and reduced its cost."

Mr. North examines in detail the conditions surrounding the growth, both of railways and waterways in the United States, showing the impetus which has been given by State, Government, and local aid; and until recently there has been freedom from those laws which are based on the theory of vested interests. Indeed the menace to invested capital is a doctrine hardly 25 years old in the United States.

"The British Government in 1853 subsidized its main lines of steamers 'to afford a rapid, frequent and punctual communication with those distant ports which feed the main arteries of British commerce, etc.'; refusing aid to, if not oppressing, internal communication. On the other hand, the Government of the United States, and also individual States, counties and localities, subsidized the turnpikes, watercourses and railroads almost entirely for the improvement of internal communications, and neglected or oppressed our efforts to reach distant ports. England is pre-eminent as a ship-building and ship-sailing country, but its people pay the highest internal freight rates known. America now has a contemptible merchant marine, but its internal freight is handled at a rate unapproached in other countries. If, as has been lately urged, the United States Government was unable to develop at one time both foreign and internal communications, it has apparently adopted the most profitable alternative, although its annual payments to foreigners for over-sea freights are said to exceed the receipts from either custom dues or the internal revenue tax."

The traffic on the Great Lakes forms an important element in the internal commerce of the United States, and a measure of the magnitude of this water transport may be found in the records of the tonnage passing through the Sault Sainte Marie canal, popularly called the "Soo." Thus the tonnage of the canal in 1881 was 1,568,000, and this rose to 8,889,000 tons in 1891, and to 36,674,437 tons in 1903!

"As only 41½ of the 958¼ miles between Duluth and Buffalo have required improvement to accommodate vessels of 20-ft. draft, and the same improvement has sufficed for the 885 miles between Chicago and Buffalo, the combined traffic on these routes being without an equal in any other channel, no other improvement undertaken by the Government has had so beneficent an effect on our national wealth, nor has returned so large a dividend on the money expended."

Summing up, Mr. North shows the great influence which has been exerted by the development of means of internal transport upon the growth of the entire country.

"The United States possesses no noticeable superiority in natural resources, and is handicapped by the necessity of finding money to do in a part of a century that for which other countries have taken nearly a thousand years. It has in the aggregate exhibited a superiority in general honesty of purpose and in the broad-mindedness of its legislators, both national and local. It is largely through legislation, notably and peculiarly in its help to all schemes for increasing wealth by diminishing the cost of interchange between producers and consumers, that the United States has attained its superiority. From the fairly equal distribution of subsidies and direct payments between waterways and railroads, there has issued a system of mutually beneficent rivalry, in that the railroads often own boat lines and the boat lines have owned railroads, which has given a higher remuneration to the producer, and a lower cost to the consumer, than would have been possible under any other system.

"As a result the internal commerce for 1902 is estimated at $20,000,000,000. This estimate is based on one transaction in each of the leading classes of commodities produced in the several different divisions of national industry. The foreign commerce amounts to nearly 12 per cent. of this sum, and 6.8 per cent. of it suffices to settle foreign balances, and pay for foreign transportation with such luxuries and raw materials as are required from other countries.

"Exclusive of the benefits derived from land grants, there seems to be no reason why any other country should not develop its transportation systems in a manner analogous to that pursued by the United States and reap as substantial a reward."

THE SPEED OF STEAM VESSELS.

THE RELATIONS OF POWER, FUEL ECONOMY AND ENDURANCE OF STEAM-PROPELLED VESSELS AT VARIOUS SPEEDS.

Commander J. F. Ruthven—Royal United Service Institution.

IN view of the important part which sea power is playing in the affairs of nations, as well as the bearing which marine efficiency has to commercial supremacy, the questions of the relations of power, speed, and fuel consumption of vessels are most important. These are discussed in an eminently practical way in a paper by Commander J. F. Ruthven, published in a recent issue of the *Journal of the Royal United Service Institution.*

"The amount of fuel required by a modern steamship, whether for the purposes of warfare or commerce, is a most important factor in estimating her usefulness and efficiency. In designing a battleship or cruiser, a torpedo boat or destroyer, as well as in the case of a mail or cargo steamer, the naval architect has, in conjunction with the engineer, to take into account the coal capacity and endurance that will, whilst fitting in with the general design, give the best results, and it behoves those who have to handle the floating mass of mechanism that constitutes a modern war vessel, or greyhound, to understand the effects of varying the speed, so as to get the best value out of the coal on board according to the object in view. In every case it is necessary to ensure its lasting to the next port, and in time of war it would certainly be desirable to have a sufficient reserve to be able to steam at extreme speed towards the end of the voyage, either for the purpose of chasing or avoiding a chaser, which might only be made possible by husbanding resources at an easier speed in the earlier stages of the passage. A modern man-of-war with her bunkers burnt out would lie helpless under the stroke of perhaps a much smaller antagonist that could choose her own time and method of attack, besides being exposed, in common with all other steam vessels in similar circumstances, to such possible dangers as a lee shore, etc.

"The capability of greater speed at a critical moment means increase of power in more senses than one. Not only does it mean more horse-power in the cylinders, but perhaps more power in using weapons that is equivalent to greater power in the weapons themselves, or, what is practically the same thing, a diminution of the offensive power of the enemy.

"The difference between the coal endurance of two cruisers may often just mean the difference in the measure of their suitability for a particular purpose, where, amongst other conditions, steaming over a long distance is entailed. This difference may conceivably arise in the same vessel under two different commanders, only one of whom looks well ahead and thinks out, in consultation with his engineer, the details of the task set him, bringing all the scientific knowledge available, as well as practical experience, to bear on it, and providing, as far as human foresight can, for every possible contingency that may arise."

Commander Ruthven accepts as generally applicable, the well-known Admiralty formula, in which the power is computed as depending on the cube of the speed and the two-thirds power of the displacement, stating that he has put it to practical test during many years of almost continuous sea service, and hence is disposed to use it until it is displaced by something admittedly better.

"The speed and consumption of a steam vessel are closely related, and whilst an accurate record of the former has always been one of the special cares of the navigator, the almost universal adoption of steam propulsion has not given him another measure of the velocity of his vessel, but has forced him to consider this in relation to the amount of fuel he has on board, to make sure that it will enable him to reach port.

"If the water did not yield to the thrust of the screw propeller, the ship would be forced ahead for each revolution as many feet as correspond to its pitch, and we should thus have an accurate measure of the speed—more accurate than any log.

"Owing to the resistance of the ship, and the water yielding to the propeller, the distance moved by the ship is usually less than that due to the revolutions and the pitch, and the difference is the *apparent* slip, or, as it is generally called shortly, the slip. It is commonly expressed as a percentage of the distance run by the propeller. The slip varies in different vessels and even in the same vessel under different circumstances, especially if there has been any alteration in the propeller. Once it has been correctly ascertained for any ship where the propeller, or propellers, are kept constantly immersed, the revolutions of the engines give, in moderate weather, the most accurate and trustworthy record of speed through the water, and it is a simple operation to make out a table of speeds corresponding to revolutions with various percentages of slip. The amount of slip to allow in each case can only be arrived at by experiment or experience, and is generally determined during the builder's trials. It rises slightly with increased speed or displacement."

Having thus at hand a convenient and reliable measure of speed, it is only necessary to keep a record of fuel consumptions at standard speeds and displacements to be able to compute the fuel consumption for any other conditions.

Here an important point enters. A considerable portion of the fuel burned under the boilers goes to generate steam to supply the auxiliaries, such as pumps, electric-light engines, refrigerating machinery, ventilators, etc. The amount of steam consumed by these does not vary with the speeds, but is nearly constant at all speeds, and hence it is important to estimate the consumption for the main engines separately from the auxiliaries. The consumption due to the main engines varies about as the cube of the speed, while the consumption of the auxiliaries is practically constant.

Thus, when a commander of a steamer finds his coal margin running low, he can readily compute the saving he can make by reducing speed, the fuel required for the main engines diminishing in proportion to the cubes of the two speeds. Thus if the speed be reduced one-half, the coal consumption will be but one-eighth, and a reduction in speed from 20 knots to 16 knots will cut the coal consumption in two. But the fuel consumption for the auxiliaries, being the same at all speeds, may fairly be measured by time, and hence it will be increased as the voyage is made longer, and the loss from this cause must be deducted from the gain realized by slowing down the main engines.

Under these circumstances the importance of improving the performance of the auxiliary machinery on shipboard will be realized, and indeed, since the paper of Mr. White, on the auxiliaries of the Minneapolis, reviewed in these columns in May, 1898, there has been increasing attention given to this matter. Thus, many engines and pumps formerly run simple, and with little or no expansion, are now made compound, while much care is given to the prevention of wasteful leaks. In many instances small engines used for operating fans and other light machinery have been replaced by electric motors, deriving current from a generating set of good efficiency, and dispensing with much piping and condensation losses. The exhaust from the auxiliaries is also used in feed water heaters and other economizing devices, and in some cases the excellent plan is adopted of arranging all the auxiliaries to exhaust into the receiver of the main engines, to the material improvement in fuel consumption.

Commander Ruthven's paper is an excellent example of the importance of looking at engineering questions from a practical, as well as a scientific point, and it forms a useful contribution to the study of current engineering problems.

THE GAS TURBINE.

A SCIENTIFIC INVESTIGATION INTO THE POSSIBILITY OF APPLYING THE TURBINE PRINCIPLE TO THE DIRECT USE OF THE GASES OF COMBUSTION.

R. M. Neilson—Institution of Mechanical Engineers.

WE have already referred in these columns to the experiments and theoretical studies which have been made upon the Continent as to the use of the gas turbine, and now we have a very suggestive paper presented before the Institution of Mechanical Engineers giving a further discussion of the important matter. Mr. Neilson writes wholly from the academic viewpoint, having made no experiments upon actual machines, and indeed, with the exception of the turbine of MM. Armengaud and Lemale, to which reference was made in our last issue, there appears to be no definite information available about any operative or operating gas turbine whatever.

Starting with the well known formula, due to Carnot, of the efficiency of an ideal heat engine, Mr. Neilson calls attention to the point that we should strive not so much to get the maximum and minimum temperatures respectively as high and as low as possible, but to get the mean temperature at which heat is given to the gas and the mean temperature at which heat is withdrawn from it respectively as high and as low as possible, the lower temperature being by far the most important.

Mr. Neilson discusses four cycles upon which good results appear possible, and shows how these may be applied to a turbine. The first of these is practically what is known as the Brayton cycle operating with combustion at constant pressure.

"It has been proposed for gas turbines to cause air and fuel to unite in a nozzle which thereafter diverges, with the idea that the air and fuel will combine on meeting each other, and the hot products of combustion then acquire a high velocity in the divergent nozzle, with which velocity they will enter the turbine buckets. The results of a trial of such a scheme would be interesting. The author doubts if the combustion would be quick enough to give a good efficiency. If, however, a combustion chamber of ample size were provided in which the burning gases could rest a short interval before passing to the turbine, better results could, in the author's opinion, be expected. The air and fuel would be separately pumped into the chamber, from which the products of combustion would flow continuously and uniformly by one or more passages into the turbine.

"At any rate, the difficulties should not be as great with turbines working on this cycle as with reciprocating engines, as the latter have to receive the hot gases intermittently, while the turbine receives a continuous flow. This is an important point as regards controlling the flame. With an engine of the Brayton type the fuel has to be ignited in the cylinder for every working stroke, and the supply of gas to the flame has to be cut for every working stroke. With a turbine the fuel and air could be supplied at a constant velocity to the flame and a steady flame maintained without interruptions. This is important, because, if a mixture of air and fuel be always supplied to the flame with a velocity greater than the velocity of propagation of the flame, there can, of course, be no firing back, and this result can be obtained without the use of a wire gauze screen. The maintaining of this velocity of supply to the flame above the required minimum when starting and stopping the motor and when running at low powers is, of course, a problem to be considered. The strength of the mixture of air and fuel should be kept constant. The power of the turbine can be varied by other means. It must be noted that if the air and fuel are compressed adiabatically to a sufficient extent, which depends on the nature of the fuel, combustion will occur immediately the two are brought into contact with each other. It is therefore necessary in such cases to keep the air and fuel apart until the instant when combustion is desired. It must also be noted that with a turbine there will be no hot waste gases mixed with the fresh air and gas to be compressed."

With this cycle a good efficiency should be attained with a moderate maximum temperature. If the temperatures are excessively high some form of water-cooling must be used, with the resultant loss of a great amount of heat. In such a machine there must also be some form of air compressor employed, and although the work required to effect the compression is returned to the turbine there is necessarily a loss due to the imperfect efficiency of the compressor, and this may be unduly great.

"Instead of employing cooling arrangements for the metal, some or all of the available heat energy of the gas can be converted into kinetic energy before causing it to act on the turbine, so that the latter is not exposed to an unduly high temperature. This can be done by allowing the gas when at the maximum temperature to expand in a divergent nozzle till its temperature falls to a degree that the turbine can stand. More than one nozzle can be employed, but, to reduce the radiation losses, the nozzles should be large and few in number.

"Suppose that the gas is compressed adiabatically to 300 lb. absolute and then is heated at constant pressure to a temperature of 2273 deg. abs. Cent. If now the gas be allowed to expand in a suitable nozzle adiabatic expansion can be obtained; and if this be continued till the pressure falls to 15 lbs. absolute the temperature will be 966 absolute Cent. (693 deg. Cent.). This is just below the temperature which was fixed on as a maximum for a turbine without artificial cooling.

"It may be advantageous to mention for the sake of comparison the velocities of the steam jets employed in De Laval steam turbines. If saturated steam at 50 lb. absolute pressure is expanded adiabatically to a pressure of 0.6 lb. absolute, which corresponds to a temperature of 85 deg. Fah., and its heat energy turned into kinetic energy, the velocity acquired works out at 3690 ft. per second. If saturated steam at 300 lb. abs. pressure were treated similarly, the velocity would be 4380 ft. per second. The velocities actually obtained in practice must be somewhat less than these figures owing to friction in the nozzles.

"To get the best results from a fluid velocity such as 5290 ft. per second would require with a single turbine wheel a vane speed which cannot be obtained at present for want of a sufficiently strong and light material—the stresses produced by centrifugal force are too great. This difficulty is experienced with De Laval turbines. The obvious way out of the difficulty is to employ several wheels in series, the gas passing through the several wheels with diminishing velocity, but with nearly constant pressure."

In the second cycle considered by Mr. Neilson is practically the same as exists with the present explosion engines, giving intermittent impulses, and delivering the fluid to the wheel at varying pressure. These difficulties may be overcome by mechanical devices, but some of the advantages of simplicity are then lost.

"With high-speed turbines there is another question to be considered. It has been stated that the velocity of the gases escaping from the divergent nozzles would be over 4000 ft. per second, if the heat energy converted into kinetic energy was as mentioned. The author is not, however, aware of any results of experiments having been published in which velocities of these amounts were obtained, when the pressure of the medium into which the divernozzle discharged was atmospheric. It is supposed by some that there is a maximum limit to the velocity of a gas leaving a divergent nozzle and escaping into a given medium which is at a given pressure, etc., and that this limiting velocity is dependent on the pressure in the medium into which the nozzle discharges, and is less when the pressure in this medium is greater and *vice versa.* That is to say, it is supposed by some that, after a certain velocity of discharge has been attained, no increase in the initial temperature or pressure will increase this velocity; but a reduction of the pressure the medium may increase this velocity. The author does not express any opinion himself on this point, but if it should be found that the reduction of the pressure inside a turbine casing below atmospheric pressure enables us to convert the heat energy of our gas into kinetic energy more effectively, this will be a further argument in favor of so reducing the pressure. Whether or not there is an advantage to be gained remains to be proved, but there is, at any rate, a possibility of gain by thus extending the expansion, and a possibility which, in the author's opinion, should not be ignored."

The third cycle proposed by Mr. Neilson includes the utilisation of the heat of the jacket water to generate steam to be mingled with the products of combustion, and delivered with them upon the wheel, this being the method used with the Armengaud and Lemale turbine. The fourth cycle includes the use of a regenerator, and offers a very high theoretical efficiency, but offset by correspondingly high practical losses.

"To produce a gas turbine cheaply it would seem necessary to entirely avoid reciprocating parts, and to be content with a low compression.

"In many cases the vibration of a reciprocating engine is extremely objectionable; and a motor that ran with practically no vibration would be popular even if its initial cost was greater, and it was more extravagant of fuel. In motor cars, for example, oil or spirit explosion engines are used for their lightness and compactness, but the vibration they cause is objectionable. If a satisfactory turbine were obtainable, there is no doubt that motor-car builders would eagerly buy it and install it on their motor cars, even if the cost was greater and the efficiency less than many arrangements of explosion reciprocating engines now in use.

THE POINT OF VIEW.

ADVICE TO ENGINEERING STUDENTS UPON ENTERING THE PRACTICAL WORK OF ACTIVE LIFE.

Walter C. Kerr—Stevens Institute of Technology.

IN an address recently delivered to a graduating class at the Stevens Institute of Technology, Mr. Walter C. Kerr gave some excellent practical hints to the young men before him, and his words will well bear reprinting and reviewing for the benefit of engineers in all stages of their professional careers. Under the general title of the "point of view," Mr. Kerr emphasises some of the lines along which the imparting and the utilisation of a technical education may be regarded. Comparing the liberal and the technical depart-
ts of education Mr. Kerr says:—

so-called liberal education has al-
highly academic. Trade-school
been strictly non-academic.
d hands fortuitously in our modern institutions. The liberal education has become less and the technical more academic, with advantage to both.

"A review of knowledge shows the great preponderance of the intellectual over the material, and it is only within late centuries, in fact almost the past century, that the human mind has seemed capable of turning from the lesser resistance of intellectual attainment to the greater capacity for physical observation and comprehension. We have but recently come to the era of intense mental operations, dealing with laws and principles which require insight greater than the intellect can grasp unless aided by the senses. Contrary, therefore, to common belief, I assert that the highest refinement of knowledge follows from the highest use of the senses; and that it has taken thousands of years of pure intellectual development to attain a state in which the powers of nature can, through the human intellect, be made useful to mankind, and add largely to knowledge."

An important feature in the true progress of technical education is the importance of keeping the profession in close practical touch with the engineering world. This means that the professor should be given the opportunity of doing a reasonable amount of practical work for commercial purposes. This may be done during a portion of his time in connection with teaching, or, as Mr. Kerr suggests, they may go periodically into the world a few years at a time, for practice. In regard to this latter suggestion, we are impelled to say that in many instances we doubt if they would feel inclined periodically to come back, but this query can be answered only by experience. Coming more directly to the student who has acquired his technical training, Mr. Kerr gives him some good advice.

"We hear much about opportunities. They are everywhere plentiful. Remember that your opportunity is the little one that lies squarely in front of you, not the large one which you hope to find further along. Many a man is surrounded with opportunities who never seizes one. There are traditions that Adam, William Tell, and Sir Isaac Newton each had an affair with an apple, but with different results.

"Your first duty is always to that which lies across your path. The only step which you can take in advance is the next one. This leads to a simplicity of action which is commendable. Don't ramble.

"Cultivate singleness of purpose. This is more important than you may think. It is intuitive with the comparatively ignorant, and often absent in the highly trained. We are frequently surprised at the great competency of the ignorant contractor or foreman, on whom judgment is often passed by saying that he is a practical man and gets results. Analysis will show that his best quality is singleness of purpose, which leads him to do vigorously the one thing before him, without distraction following from thinking about too many other things.

"Remember that all the good you accomplish is going to come out of yourself. You cannot borrow it and you cannot make it out of that which has been poured into you by education or otherwise. All that you receive is only a certain quantity of knowledge, acquired by education, experience, or other training, which will have a certain influence upon what comes out of yourself as your own. It is the inherent capacity to perform with your own brain which will make you what you become, and not the mere transmission of that which you have acquired. Your knowledge, therefore, is of little avail until you make it inherently a part of yourself through mental assimilation and utilisation. The clearer you comprehend these things, the more readily you can make use of them as against the process of mere acquirement with a vague motive that in some way or other what you acquire may be of benefit, or that environment will be the force that makes your talent effective. Some have gone through experience without acquiring it, and many a man who has received an education has not got any because he allowed it to be a thing apart from his personality and it slipped away."

MODERN METHODS OF TESTING MATERIALS.

DETERMINATIONS OF HARDNESS, BRITTLENESS, AND ELASTIC LIMIT BY PRACTICAL AND USEFUL METHODS.

Société d'Encouragement pour l'Industrie Nationale.

AN appendix to the valuable Bulletin of the French society for the encouragement of national industry is entitled the *Revue de Métallurgie,* and this often contains most valuable papers relating to this department of the work of the engineer. Among these we note in a recent issue an article by M. Guillery, discussing some of the modern methods of determining the resistance of materials of construction, and of their applications to practical work.

Formerly the tension test was considered of the first importance, and its great value is undoubted, although the usefulness of the information to be obtained directly from a mere statement of the ultimate resistance of a material in tension is a matter which is open to question. At the present time it is realized that the practical information desired is that of the behaviour of the material under conditions more nearly approaching those under which it is actually employed, and that its elastic limit, its resistance to pressure and to shock are the things which the constructor really desires to know.

At the new workshops at Denain, operated by the Company which has succeeded to the business of the old and well-known firm of Cail et Cie. the installation of practical shop methods of testing has been entrusted to M. H. Le Chatelier, and it is an account of these methods which is contained in the paper of M. Guillery.

Leaving aside for the moment the methods admittedly suitable for the research laboratory, M. Guillery discusses the conditions and requirements for satisfactory methods of shop testing. Broadly, the methods used should give precise indications of the quality of the metal, without leaving anything to the judgment of the operator, and these indications should be obtainable at low cost, in little time.

M. Guillery believes that the most important tests for the shops are those of hardness, or resistance, and brittleness, or resistance to impact or blows. Taking the Brinell system of determining hardness by the impression made by a steel ball he has employed simple devices for enabling this test to be made in a manner which shall enable strictly comparable results to be obtained by comparatively unskilled persons. Two forms of apparatus are described, one portable, and capable of being applied to any portion of a machine or structure, the other fixed for general shop use. In both the pressure upon the ball is determined by a number of disc springs, of the Belleville type, these being enclosed in a cylindrical case with a socket for the steel ball at one end. In the fixed apparatus the pressure is exerted by an arrangement of lever and cams, and when the movement is limited by a stop the springs have been compressed a determinate amount so that the pressure exerted upon the ball is always the same. It is only necessary to polish a small area of surface of the material to be tested, and press the ball upon it in the apparatus, and the diameter of the indentation gives a measure of the hardness and resistance. The tensile resistance is also determined by this test, since it has been shown by experiment that a direct relation exists between the impression made by the ball and the tensile strength of the material. Such an instrument is best calibrated by experiment, and it has been found that an excellent material for calibration tests is the standard bronze used for subsidiary coinage, this being readily obtained and of very uniform composition and strength.

M. Le Chatelier has devised a simple form of diagonal scale engraved on glass, which enables the diameter of the impression of the steel ball to be measured to the tenth of a millimetre by the unaided vision.

The portable apparatus is identical in construction and operation with the stationary machine with the exception that the pressure is exerted by a blow, this being taken up by the springs and converted into a determinate pressure upon the steel ball.

The great advantage of this device lies in the fact that reliable tests may be made upon the actual materials and parts composing the machine or structure under consideration, and that it does not require a separate test piece to be used. In this way all uncertainty as to the manner in which the test piece represents the material in the completed article is removed, and a far greater degree of satisfaction secured. It is possible to test portions of a structure already completed and enable comparative results to be obtained from the different parts of the same piece of work.

The impact tests made by M. Guillery are based upon the principle of breaking a nicked bar, following the practice of Barba, Fremont, Charpy, and other authorities. For making these tests, however, he employs a very simple and convenient machine, employing rotary motion, instead of the falling ram used by Fremont and others.

The apparatus consists of a sort of small fly wheel, with heavy rim, and crank and gearing device by means of which it may be rotated at a speed of about 300 revolutions per minute. A projection on the face of the wheel is arranged so that it will strike the test bar at the proper place when the latter is pushed towards it; this being done when the wheel has attained the proper speed. A speed indicator shows the velocity of the wheel at any moment, and the loss of speed following the breaking of the bar is an accurate measure of the work absorbed in overcoming the resistance offered. The machine is arranged so that the frictional losses are reduced to a minimum, and since it has been found that correct results are obtained by the use of small bars, or *barrettes,* as they have been termed, the whole apparatus is of moderate dimensions.

By the use of such devices as are described in the paper of M. Guillery it has been found possible to maintain a close control over the quality of the materials used in the large works at Denain, and there appears to be no good reason why such simple appliances should not find useful application in many places. There is no doubt that testing would be much more frequently performed if it could be more readily done, and if the general character of a material could be ascertained within reasonable limits of error directly in the course of its passage through the shop the reliability of the products should be vastly increased.

It is not to be assumed that the use of such methods as are described in the paper of M. Guillery are intended to supersede the employment of accurate and precise testing machines in the mechanical laboratory. The fact that the work has been under the supervision of such a high scientific authority as M. Le Chatelier is sufficient indication that the limitations of the methods have been fully understood and appreciated.

TERNARY ALLOY STEELS.

PROPERTIES, CLASSIFICATION, AND UTILISATION OF SPECIAL STEELS CONTAINING CARBON AND AN ALLOYING METAL.

Leon Guillet—Société des Ingénieurs Civils de France.

FORMERLY steel was the name given to certain combinations of iron and carbon, but of late it has become evident that carbon is but one of the elements which may be combined with iron to form a steel, and indeed engineers have begun to use the somewhat indefinite term "carbon" steel to mean a steel which contains only carbon and iron, in distinction from those which are made with other constituents.

The properties of the so-called "alloy" steels have been given careful study by the French metallurgist, M. Leon Guillet, and various papers upon the subject have appeared by him in the technical press, some of these having already been noticed in these columns. In a paper recently contributed by him to the *Mémoires* of the Société des Ingénieurs Civils de France, the special ternary steels are given a systematic study in a very complete and useful manner.

By a "ternary" steel M. Guillet explains that he means a steel containing iron, carbon and one other metal, this last being intentionally added to produce definite qualities in the product. The steels considered in the paper include those to which have been added in various proportions the metals nickel, manganese, chromium, tungsten, molybdenum, vanadium, silicon, titanium, aluminum, cobalt, and tin.

The paper is divided into sections treating of each of these alloys, and the various sections discuss the preparation, properties, and applications of the products. In such an exhaustive treatment of a most important subject it is impracticable for us to do more than call attention to the most important points brought out, leaving the engineer to examine the original memoir, as a most valuable contribution to the materials of engineering.

In studying the different alloy steels M. Guillet has made use of the methods of metallography, or microscopic photography, as well as those of mechanical testing. The latter work included tension tests upon machines provided with automatic recorders, drop tests according to the method of Fremont, using nicked bars, and hardness tests by the method of Brinell, based on the impression made by a steel ball. The elastic limit was determined in some cases from the diagram made by the testing machine, and in others by the method of Fremont, observing the moment at which the polished surface of the test piece lost its brilliancy.

M. Guillet treats first of the nickel steels, dividing these into three classes, pearlitic, martensitic, and polyhedric, according to their micrographic appearance. The pearlitic steels, containing about 0.12 carbon and 2 per cent. of nickel, are very homogeneous, offering a high resistance to shocks, and being well adapted to surface hardening by cementation. Among the higher alloys mention is made of the 36 per cent. nickel alloy, known as invar, because of its freedom from appreciable expansion or contraction by heat, and of the 48 to 50 per cent. alloy, called platinite because it possesses the same coefficient of expansion as platinum or glass, and hence may be used as a substitute for platinum wire in fusing into glass.

Manganese steels, originated in 1888 by Hadfield, are prepared by the addition of ferro-manganese, this alloy, as made in the blast furnace, containing as high as 80 per cent. of manganese and 7 per cent. of carbon. A very pure ferro-manganese is prepared in the electric furnace, or by the Goldschmidt process of aluminothermy. The manganese steels used in practice contain about 5 per cent. of manganese and 0.80 carbon, and by reason of their combined hardness and toughness find numerous useful applications, such as the construction of jaws for crushers, grinding rolls, etc. M. Guillet believes that manganese steels are capable of much wider use, and that it is possible that they may replace nickel steel for some purposes, at lower cost.

Passing over the chrome steels, we come to the alloys containing tungsten and molybdenum, these being of present interest in connection with the manufacture of high-speed tool steels.

Tungsten steel is readily made in the crucible, either by the use of ferro-tungsten or metallic tungsten. Ferro-tungsten is made in the electric furnace, and contains about 80 per cent. of tungsten and 8 to 9 per cent. of carbon. Metallic tungsten is made, either in the electric furnace or by the process of aluminothermy.

In his study of the properties of tungsten steels M. Guillet observes that the tungsten appears to exist in combination with the carbon as a carbide, at least when the content of tungsten is relatively high. The principal application of tungsten steel is in connection with the manufacture of tools, and the modern self-hardening high-speed steels contain 10 per cent. or more of tungsten. M. Guillet observes, however, that the presence of tungsten alone imparts but a small degree of air-hardening property to a steel, this requiring also the presence of chromium or manganese, and thus bringing the product out of the class of ternary steels. Tungsten steels have been advocated for springs, but M. Guillet believes that they are inferior for this purpose to steels containing silicon. Molybdenum steels are similar in their properties to the tungsten steels, and like them require the presence of chromium or manganese for the production of air-hardening tools. Apparently there is no especial reason for preferring molybdenum to tungsten, and the latter has the advantage of being less costly.

Among the other alloy steels discussed by M. Guillet are silicon, titanium, aluminum and tin alloys, concerning which reference must be made to the original memoir.

The general properties of the various ternary steels are arranged by M. Guillet in curves, and also summed up in a series of conclusions; mainly according to their structure.

Among the pearlitic alloys a certain number may well be employed in the place of carbon steels, this especially being the case with nickel steel, and probably with manganese steel. The martensitic steels offer fewer practical applications, although some of them may be found useful for special tools. The polyhedric steels have doubtless a brilliant future if they can be produced at a reasonable cost, but it will always be necessary to take into account their low elastic limits. Among the double carbide steels only those containing tungsten and molybdenum appear to be of practical importance, because of their special property of remaining very hard after tempering, this fitting them particularly for cutting tools.

At the present time there appears to be no practical application for graphitic steels.

THE ENGINEERING INDEX

"THE KEYSTONE
·IN·THE·ARCH·OF·APPLIED·SCIENCE"

The following pages form a DESCRIPTIVE index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 445
ELECTRICAL ENGINEERING 450
INDUSTRIAL ECONOMY 454
MARINE AND NAVAL ENGINEERING 455
MECHANICAL ENGINEERING 456
MINING AND METALLURGY............. 464
RAILWAY ENGINEERING 469
STREET AND ELECTRIC RAILWAYS....... 472

CIVIL ENGINEERING

BRIDGES.

Accident.

A Remarkable Accident to a Masonry Arch Bridge. From the *Zeitschrift des Vereines Deutscher Ingenieure.* An account of two arches, which were built three-hinged, slipping off their hinges, at Munich, Germany. 1800 w. Eng News—Oct. 27, 1904. No. 65814.

The Accident at the Maximilian Bridge in Munich (Der Bauunfall des Aüsseren Maximiliansbrücke in München). W. Dietz. Describing the displacement of one of the abutment hinges of a three-hinged masonry arch during erection. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1904. No. 65701 D.

Draw-Bridge.

An Interesting Draw-Bridge Built Mostly of Wood in Forty Working Days. Martin Scheiber. Description, with illustrations, of an interesting piece of engineering work on the White Line between Paterson and Hoboken, N. J. 1500 w. St Ry Rev—Sept. 20, 1904. No. 65473 C.

Foot Bridge.

The Ticonic Foot Bridge, Waterville,

Me. Illustrated description of a bridge crossing the Kennebec River. It is a steel structure with a 400-ft. suspended span and two through truss approach spans. 1800 w. Eng Rec—Oct. 15, 1904. No. 65564.

Highway Bridge.

The New Highway Bridge over the Thur at Billwil-Oberbüren (Die Neue Strassenbrücke über die Thur bei Billwil-Oberbüren). Describing a peculiar form of reinforced concrete bridge with two arches of 35 metres span each. 1200 w. Schweiz Bauzeitung—Oct. 1, 1904. No. 65767 B.

Railroad Bridge.

Forest Park Bridge of the Wabash at St. Louis. A. O. Cunningham. Illustrated description of a new ornamental structure in keeping with the surroundings, having a clear span of 70 feet. 1500 w. R R Gaz —Vol. XXXVII., No. 20. No. 65834.

Rebuilding.

Rebuilding a Wrecked Railroad Bridge at Easton, Pa. Describes the condition of the bridge after being wrecked, the temporary repairs to maintain traffic, and the final rebuilding. Ills. 3500 w. Eng Rec —Oct. 1, 1904. No. 65423.

Reinforced Concrete.

Concrete Test Arch of the Stuttgart Cement Works at Blaubeuren near Ehingen (Beton Probebogen der Stuttgarter Zementfabrik Blaubeuren in Ehingen). H. Hoch. Illustrated description of a test of a reinforced concrete arch of 20 metres span by loading it to destruction. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 24, 1904. No. 65708 D.

Skew Bridge of Armored Concrete. From *La Genie Civil*. Illustrated description of a bridge recently erected over the river Aisne, which is an interesting example of this type of construction. 4000 w. Engr, Lond—Oct. 7, 1904. No. 65577 A.

Suspension.

A Rational Form of Stiffened Suspension Bridge. Discussion of the paper by Gustav Lindenthal. 8800 w. Pro Am Soc of Civ Engrs—Oct., 1904. No. 65823 E.

Theory and Formulas for the Analytical Computation of a Three-Span Suspension Bridge with Braced Cable. Irving P. Church. Discussion of paper by Leon S. Morsseiff. 1200 w. Pro Am Soc of Civ Engrs—Oct., 1904. No. 65822 E.

Three-Hinged Arches.

A New Graphical Method for Stresses in Three-Hinged Arches. J. W. Balet. The explanation of the method considers only the three-hinged braced arch, although it is of general application to arches with or without hinges, braced or solid rib. 2800 w. Eng News—Oct. 20, 1904. No. 65637.

Viaduct.

Viaduct Erection on Section 10, New York Rapid Transit Railroad. Illustrates and describes some special features that have developed in the work, showing some traveler details. 2000 w. Eng Rec—Oct. 8, 1904. No. 65461.

CONSTRUCTION.

Excavating.

. A Cable Power Scraper for Earth Excavation. C. G. Newton. Sketches, photographs and brief description of a steam scraper which has been used considerably on the Pacific coast, and has proved an economical machine. 500 w. Eng News —Oct. 20, 1904. No. 65635.

Girders.

A New Geometric Method of Computing the Forces Acting upon Continuous Girders (Nouvelle Determination Géométrique des Efforts dans les Poutres Droites à Travées Continues). Farid Boulad. Deriving equations and diagrams applicable to various conditions of loading. 1200 w. Génie Civil—Oct. 8, 1904. No. 65724 D.

Pillars.

The Buckling Formula of Rankine and Schwarz in the Form of a Graphical Diagram (Darstellung der Knickungsformel von Rankine und Schwarz in Form von Zeichnerischen Rechentafeln). Alexander Coulmas. Showing the method of drawing curves to represent the formula, and the transformation of these into straight lines. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 30, 1904. No. 65727 D.

Reinforced Concrete.

A Brief Mention of Some Minor Uses of Reinforced Cement in Subway Construction. Alfred Craven. A brief illustrated description of several adaptations of this material. 1000 w. Cement Age—Sept., 1904. No. 65357.

Concrete and Concrete-Steel. Abstract of a paper by A. Considère, presented before the Int. Engng. Cong., St. Louis. Discusses the materials used, arrangement, calculations of bending moments and shears, of sizes and deformations of reinforced beams, etc. 2700 w. R R Gaz—Vol. XXXVII., No. 20. No. 65835.

Economy in the Use of Steel Concrete. John B. Warren. Describes structures of steel-concrete construction with solid floors to show the saving in first cost as compared with the ordinary steel I-beam construction. Ills. 1800 w. Eng Rec—Oct. 15, 1904. No. 65566.

The Relation of the Ceiling to the Strength of the Girders in Reinforced Concrete Construction (Note sur la Participation du Hourdis à la Résistance des Nervures dans les Constructions en Béton Armé). Henry Lossier. An examination of floor and ceiling construction in reinforced concrete, showing the extent to which the ceiling itself aids in supporting the load. 1500 w. Schweiz Bauzeitung—Sept. 24, 1904. No. 65766 B.

See also Civil Engineering, Bridges.

See also Civil Engineering, Municipal Engineering.

Structural Work.

The Structural Design of Buildings. C. C. Schneider. Submits a set of specifications, for the structural work of buildings, for discussion and criticism, explaining some of the more important clauses and giving the reasons which led the writer to adopt them. 11000 w. Pro Am Soc of Civ Engrs—Sept., 1904. No. 65354 E.

Tunnels.

Some Notes on the Early History of the Hudson River Tunnel. S. D. V. Burr. Describes features of this work which have passed out of use, and are of historical value. Ills. 2500 w. RR Gaz—Vol. XXXVII., No. 18. No. 65554.

Subaqueous Tunnelling. Sir Alexander Binnie. Considers, exclusively, those tunnels which have had to be constructed in water-bearing strata in close proximity to the channel bed. Ills. 9500 w. Public Works—Oct. 15, 1904. No. 65622 D.

The Gravehals Tunnel, Norway. Illustrated description of the construction of a tunnel 5,300 metres long, which ranks as the seventh or eighth of the large tunnels of the world. 3300 w. Public Works—Oct. 15, 1904. No. 65625 D.

The Harlem River Tunnel Section of the New York Rapid Transit Railway. Illustrated description of the method of building the eastern half of the tunnel, radical changes having been made with the approval of the Chief Engineer. 2500 w. Eng News—Oct. 13, 1904. No. 65543.

MATERIALS OF CONSTRUCTION.

Cement.

Testing Portland Cement. James Nangle. Describes tests for soundness, firmness of grinding, and tensile strength to determine whether cement is safe to use. Ills. 3500 w. Aust Min Stand—Sept. 8, 1904. No. 65592 B.

Concrete.

Concrete in Subway Work. George W. Rice. An illustrated account of interesting concrete work, and methods of construction. 1200 w. Cement Age—Sept., 1904. No. 65356.

Concrete Mixers. Joseph Horner. Brief review of the development in these mixers and the cause, the designs and latest improvements. Ills. 3000 w. Public Works—Oct. 15, 1904. No. 65626 D.

Cost of Concrete Structures. H. M. Jones. Extracts from a paper presented to the Engng. Assn. of the South. A detailed statement of cost for concrete culverts and other small structures. 3500 w. R R Gaz—Vol. XXXVII., No. 19. No. 65655.

Metal Protection.

Protecting Low Overhead Structures from Gases and Blasts of Locomotives. Statements presented as the report of a committee at the convention of the Association of Railway Superintendents of Bridges and Buildings at Chicago. 1600 w. Eng News—Oct. 27, 1904. No. 65812.

Timber.

The Shrinkage and Warping of Timber. Harold Busbridge, in *Technics*. Illustrates and describes the behavior of wood treated in different ways. 1000 w. Sci Am Sup—Oct. 1, 1904. No. 65387.

MEASUREMENT.

Formula.

An Improved Formula for the High Masonry Dam. F. W. Crocker. Devises a method by which the processes of the American Formula may be abbreviated. 4200 w. Cal Jour of Tech—Sept., 1904. No. 65510 C.

Graduations.

A Cause of Errors in Graduated Circles (Sur une Cause de Variabilité des Erreurs de Division dans Certains Cercles Gradués). C. Bigourdan. An examination of the appearance of errors subsequent to graduation, caused by the unequal expansion of the materials. Iron is inferior to brass as a support for the graduated silver circle. 1000 w. Comptes Rendus—Sept. 26, 1904. No. 65747 B.

Level Recorder.

The Electric Long-Distance Water Level Recorder on the Wien River at Hadersdorf-Weidlingau (Der Elektrische Wasserstands-Fernmeldeapparat bei den Wienflussregulierungsanlagen in Hadersdorf-Weidlingau). Hans Baumeister. Describing an apparatus for enabling a continuous diagram of the water level in a reservoir to be recorded at a distance of half a kilometre. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 7, 1904. No. 65728 D.

Surveying.

The Completion of the Longitude Girdle of the Globe: Determination of the Difference in Longitude Between San Francisco and Manila. Edwin Smith. Gives results of the recent determination, describing the methods. 3500 w. Eng News—Oct. 6, 1904. No. 65479.

Tacheometry.

Notes on Tacheometry: A Comparison of Systems. Arthur L. Bell. A comparison of the two main systems of staff holding—staff vertical, and staff at right angles to line of sight. Ills. 1500 w. Engng—Oct. 21, 1904. No. 65836 A.

MUNICIPAL.

Pavements.

Convict Labor on a Standard Pavement. Describes the construction of a standard smooth pavement with the aid of convict labor in Fulton County, Georgia. Ills. 1800 w. Munic Engng—Oct., 1904. No. 65373 C.

Sewage Disposal.

Experiments in Purifying Brewery Refuse. From an account by H. Maclean Wilson of some experiments in the purification of brewery works at Rotherham. 1300 w. Eng Rec—Oct. 8, 1904. No. 65464.

Scientific Disposition of Sewage. Charles F. Holder. Describes the very successful disposition of sewage from the city of Pasadena, Cal. 1700 w. Sci Am—Oct. 22, 1904. No. 65641.

Sewage Purification Works for Small Populations. Arthur J. Martin. Read before the Inst. of San. Engrs. States some difficulties met with in dealing with sewage of small communities and the requirements of such plants. 5300 w. Builder—Oct. 22, 1904. No. 65849 A.

Sewage Purification Works Under Construction at Minworth Greaves, England. Information from a paper by A. Bryan, before the Assn. of Munic. Co. Engrs. Describes the intake chamber, experimental beds, percolating beds, the use of aerated floors, etc. 3800 w. Eng Rec—Oct. 8, 1904. No. 65462.

Sewage Treatment in Great Britain and Some Comparisons with Practice in the United States. M. N. Baker. Introduction to recently published works. Shows the dissimilarity in the conditions affecting the treatment, and gives a summary of the main features of British works recently visited, with conclusions and comments. 2500 w. Eng News—Oct. 6, 1904. No. 65480.

The Royal Commission on Sewage Disposal. A review of the Commission's fourth report. 2800 w. Engr Lond—Oct. 7, 1904. Serial. 1st part. No. 65578 A.

The Sewage Testing Station at Columbus, Ohio. John H. Gregory. An illustrated detailed description of the station and its equipment. 2400 w. Eng News—Oct. 20, 1904. No. 65639.

Sewers.

A Concrete-Steel Sewer at Harrisburg, Pa. An illustrated description of the design and construction of the Paxton Creek intercepting sewer, with report of cost. 3500 w. Eng Rec—Oct. 15, 1904. No. 65561.

Diagram Giving Dimensions of Conduits of Equal Capacity. Gives a convenient diagram for determining quickly the dimensions of horse-shoe shaped cross sections of equivalent discharging capacity to given circular sections, and vice versa. 1100 w. Eng Rec—Oct. 8, 1904. No. 65466.

Reinforced Concrete Sewers in Wilmington, Del. Photographs and drawing, with description of the work. 1200 w. Munic Engng—Oct., 1904. No. 65374 C.

Sewer Trenching and Gas Mains. Notes based upon a paper read before the Eastern Counties Gas Managers' Association, by E. G. Smithard, concerning difficulties met with in constructing a sewerage system at King's Lynn. 2000 w. Eng Rec—Oct. 22, 1904. No. 65667.

Underground Structures.

Losses in Underground Municipal Structures. Prof. A. Prescott Folwell. Read before the Am. Soc. of Munic. Imp. Discusses the enormous loss and inconvenience caused by present methods of managing street surface and sub-surface structures. Considers the sources of loss separately, and possible remedies. 2500 w. Eng Rec—Oct. 15, 1904. No. 65565.

WATER SUPPLY.

Copper Treatment.

The Use of Copper Sulphate to Prevent Algæ Growths at Hanover, N. H. Prof. Robert Fletcher. Brief description of this manner of purification and its complete success. 700 w. Eng News—Oct. 27, 1904. No. 65815.

Deposits.

Deposits in Water Pipes and Other Channels. Notes from a paper by Prof. James Campbell Brown, read before the Inst. of Civil Engrs. (England). Considers incrustations on imperfectly protected iron pipe, and deposits on the inner surface of iron pipes, culverts, and other channels. 1800 w. Eng Rec—Oct. 1, 1904. No. 65422.

Ground Water.

Some Geological Principles of Subterranean Water Supply. F. J. H. Merrill. Discusses deep wells in soft rocks, and deep wells in hard rocks. 1100 w. Eng News—Oct. 20, 1904. No. 65640.

Purification.

Coagulation Plant at the Settling Basins at St. Louis, Mo. E. E. Wall. Describes the new process in use at St. Louis for clarifying and purifying the Mississippi River water. 1800 w. Eng News—Oct. 27, 1904. No. 65816.

The Purification of Water. Prof. John M. Ordway. Extract. Remarks on methods used for removing color, iron, hardness, etc. 2800 w. Am Mach—Vol. 27, No. 39. No. 65361.

Reservoir.

Lake Cheesman Dam and Reservoir. G. S. Williams. Continued discussion of paper on this subject by Charles L. Harrison, and Silas H. Woodard. 7500 w. Pro Am Soc of Civ Engrs—Sept., 1904. No. 65355 E.

Troy, N. Y.

The New Water Supply of Troy, N. Y. William G. Raymond. Reviews the past history of the supply and gives an illustrated description of recent important engineering work to increase the supply. 6300 w. Eng News—Oct. 6, 1904. No. 65477.

Water-Works.

The New Water-Works of East Orange, N. J. Illustrated description of a municipal system comprising artesian wells, a pumping station, a 24-in. river main 5 miles in length from the pumping station to a concrete reservoir, and a gravity distribution system. 3000 w. Eng Rec—Oct. 22, 1904. No. 65668.

WATERWAYS AND HARBORS.

Canals.

Proposed Canal to Connect Montreal with the Head of Lake Huron. Day Allan Willey. An explanation of the discussed plan and the advantages it would give. 1600 w. Sci Am Sup—Oct. 29, 1904. No. 65819.

Channel.

Transport Across Maritime Channels. G. Leinekugel le Cocq. An illustrated review of the main ways of establishing communication between opposite shores of maritime waterways in such a manner as not to interfere with the passage of vessels having lofty masts. 5000 w. Public Works—Oct. 15, 1904. No. 65627 D.

Dam.

The New Charles River Dam and Basin at Boston, Mass. J. Albert Holmes. An account of the plans being matured for the construction of this dam, stating the conditions. 1100 w. Eng News—Oct. 6, 1904. No. 65478.

Docks.

New Graving Dock at Helburn. Illustrated detailed description. 1500 w. Engr, Lond—Oct. 21, 1904. No. 65844 A.

The Design of a Dry Dock. Alfred W. Young. Read before the Junior Inst. of Engrs. Considers the subject chiefly in regard to stability of structure rather than the elements effecting the outline. Ills. 5000 w. Engng—Sept. 30, 1904. No. 65526 A.

Drainage.

The Drainage of Inner Basins, Mississippi Levee System. Charles Le Vasseur. Slightly condensed from a paper published in the *Journal of the Memphis Engineers' Society*. Considers the drainage of the areas inclosed by the completion of the levees, and having no outlet. Describes the method of disposing of this water. 1800 w. Eng News—Oct. 27, 1904. No. 65813.

Dredge.

The Hydraulic Dredger. "J. Israel Tarte." A. W. Robinson. Read before the Canadian Soc. of Civ. Engrs. A detailed account of the dredger and its work, with illustrated description. 7500 w. Engng—Oct. 21, 1904. No. 65840 A.

Groynes.

Groynes. A. T. Walmisley. Illustrated article describing various forms of construction used, and discussing the systems, their good and ill effects. 4200 w. Public Works—Oct. 15, 1904. No. 65624 D.

Harbor Plant.

See Mechanical Engineering, Internal-Combustion Motors.

Nile.

The River Nile and Irrigation in Egypt. An editorial discussion of the report of Sir William Garstin. 3800 w. Engng—Oct. 7, 1904. No. 65574 A.

Quays.

Skeleton Quays for Docks, Harbors, Wharfs, etc. R. C. Bullock. Describes quays designed to carry a load from 3 cwt. to 5 cwt. per sq. ft. without using superfluous material, and so decreasing the cost. Ills. 600 w. Prac Engr—Sept. 30, 1904. No. 65517 A.

MISCELLANY.

Explosion.

The Antwerp Petroleum Explosion. An illustrated account of the explosion on August 26, discussing the arrangements for storage. 1600 w. Engng—Oct. 21, 1904. No. 65839 A.

Hospital Engineering.

Engineering at Guy's Hospital. Begins a description of a hospital plant that has recently been remodeled. 1500 w. Engr, Lond—Oct. 14, 1904. Serial. 1st part. No. 65696 A.

Simplon.

The Simplon Tunnel. Francis Fox. A brief illustrated account of this work, the difficulties encountered, and conquered, the present condition, and the probable junction of the headings. 1500 w. Nature—Oct. 27, 1904. No. 65939 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Accumulators.

The Use of Accumulators to Supply Current for Microphones in Telephony (Akkumulatoren als Stromquelle für die Mikrophone der Fernsprechstellen). Ludwig Brückmann. Discussing the substitution of central-station storage batteries for local primary batteries for telephones. 3000 w. Elektrotech Zeitschr—Sept. 22, 1904. No. 65730 B.

Conductors.

The Transposition of Electrical Conductors. Frank F. Fowle. Mathematical and practical discussion of the transposition of telephone and of power circuits to avoid electric and magnetic disturbances. 3500 w. Trans Am Inst of Elec Engrs—Oct. 28, 1904. No. 65825 D.

Duplex.

The Duplex Balancing of Telegraph Cables. W. Gaye. Notes arising out of a little study of the operational methods of Mr. Oliver Heaviside in connection with the balancing of cables for the purpose of duplex telegraphy. 2500 w. Elect'n, Lond—Sept. 23, 1904. Serial. 1st part. No. 65447 A.

Japan.

Telegraph and Telephone Systems in Japan and Central Stations. From *L'Electrician.* Brief account showing how rapidly the Japanese adopted and installed telegraph and telephone lines, and their facility in operating and constructing them. 1200 w. Sci Am Sup—Oct. 15, 1904. No. 65545.

Space Telegraphy.

A Recent Wireless Telegraph Patent. Describes an "Improved Mode of and Apparatus for Producing and Detecting Hertzian Oscillations," patented by J. Nevil Maskelyne. 3000 w. Elect'n, Lond —Oct. 14, 1904. No. 65690 A.

Electrolytic Receivers in Wireless Telegraphy. Dr. Leede Forest. Briefly reviews the field of cohering indicators of electric waves, and considers recent investigations leading to forms of receivers based on the electrolytic principle which are attracting much attention. General discussion. 7000 w. Jour Fr Inst—Oct., 1904. No. 65435 D.

The Theory of Wireless Telegraphy. Dr. John Stone Stone. Presented before the Inst. Elec. Cong. at St. Louis. Gives the popular theory and the working theory of that form of wireless telegraphy in which electrical vibrations are set up in electrical oscillators whose axes are normal to the earth's surface, and which are connected to the earth's surface at their lower extremities. 5000 w. Elec Rev, N Y—Oct. 15, 1904. No. 65652.

Wireless Telegraph Aerial Wires and Earths. A. Frederick Collins. From advance sheets of a work in press. Gives illustrated descriptions of the forms of ordinary aerials, with explanation of the theories advanced. 3600 w. Elec Wld and Engr—Oct. 15, 1904. No. 65605.

Wireless Telegraphy at the St. Louis Exposition. Lloyd Marshall. An illustrated article describing the stations and their working. 1000 w. Cassier's Mag—Oct., 1904. No. 65350 B.

Telautograph.

Telautograph. James Dixon. Reviews the development of electrical transmission of handwriting, and describes the telautograph and its recent improvements, operation, etc. 3500 w. Trans Am Inst of Elec Engrs—Oct., 1904. No. 65608 D.

Telegraphy.

Mercadier's System of Attuned Telegraphy. An explanation of the tuning-fork system for manifold telegraphy. Ills. 2500 w. Sci Am Sup—Oct. 8, 1904. No. 65484.

Telephony.

Planning a Telephone System. Samuel G. McMeen. Read at the St. Louis convention of the Ind. Tel. Assn. of the U. S. A discussion of rules to be applied in planning a telephone system at minimum costs. 2500 w. Elec Rev, N Y—Sept. 8, 1904. No. 65505.

Wiring.

Interior Wiring for Telephones. Charles H. Coar. Discusses points of importance, and gives rules applicable in many cases. 2200 w. Elec Wld and Engr—Oct. 15, 1904. No. 65604.

DISTRIBUTION.

Arresters.

An Experiment to Illustrate the Principle of Horn Arresters. A. E. Moore. Describes an experiment made to determine whether connection or electromagnetism plays the more important part. The result shows that connection plays only a small part. 900 w. Elec Engr, Lond—Oct. 7, 1904. No. 65583 A.

Conductors.

Approximate Methods of Computing Conductors for a Given Loss of Energy

(Näherungsverfahren zur Berechnung Elektrischer Leitungen bei Gegebenen Arbeitsverlust). Léopold Rosenbaum. A mathematical discussion showing methods of abridging the work of computation. 2000 w. Zeitschr f Elektrotech—Oct. 2, 1904. No. 65757 D.

Regulation.

A New Method of Regulating the Pressures in a Distribution System (Ein Neues Verfahren zur Spannungsregelung in Stromverteilungsnetzen). Dr. E. Müllendorf. A discussion of the varying demands of different parts of a city for current, and the necessity of taking this into account in the distributing system. 3000 w. Elektrotech Zeitschr—Oct. 6, 1904. No. 65742 B.

Rotary Converters.

Practical Management of Rotary Converters. F. P. de Wilde. An explanation of two general methods of operating rotaries. Diagrams. 2200 w. Am Elect'n—Oct., 1904. No. 65434.

Three-Phase.

The Question of Excess Pressure in Three-Phase Installations (Ein Beitrag zur Frage der Ueberspannungen in Dreiphasenstrom Anlagen). P. Humann. A discussion of the danger to a cable by excess of pressure caused by the burning out of a fuse or other disturbance of balance. 2000 w. Elektrotech Zeitschr—Oct. 13, 1904. No. 65744 B.

Three-Wire.

Three-Wire Distribution. F. Hardie Jeannin. Description of the three-wire system and its modifications, discussing its good and bad features, its applications, etc. Diagrams. 4000 w. Elec Wld and Engr—Oct. 22, 1904. No. 65678.

ELECTRO-CHEMISTRY.

Electrolysis.

Differences in the Electrolysis of Potassium Chloride and Sodium Chloride. F. Winteler. Discusses in detail the differences stated. 2000 w. Elec Chem Ind—Oct., 1904. No. 65502 C.

Iron.

Electrolytic Iron (Ueber das Elektrolyteisen). A .Skrabal. A study of the physical and chemical properties of iron produced by electrolytic deposition. 2000 w. Zeitschr f Elektrochemie—Sept. 23, 1904. No. 65772 G.

ELECTRO-PHYSICS.

Conduction.

The Conduction of Electricity in Mercury Vapor. A. P. Wills. Abstract of an article in the *Physical Review* of New York. Experimental investigation of the conducting properties of the "positive column." 3800 w. Elect'n, Lond—Oct. 21, 1904. No. 65846 A.

Hysteresis.

The Energy Dissipated in Iron by Hysteresis at High Frequencies (Sur l'Energie Dissipé dans le Fer par Hysteresis aux Fréquences Elevees). C. E. Guye & A. Schidlof. Tabulated results of experiments, showing that the energy consumed is independent of the speed. 800 w. Comptes Rendus—Sept. 26, 1904. No. 65748 B.

Radioactivity.

The Phenomena of Radioactivity (Ueber die Erscheinungen der Radioaktivität). Dr. Gottfried Diemer. A review of radioactive emanations and the methods employed for observation and study. Two articles. 4000 w. Zeitschr f Elektrotechnik—Sept. 25, Oct. 4, 1904. No. 65756 each D.

Striking Distance.

The Law of Electric Striking Distance Through Atmospheric Air (Ueber das Elektrische Durchschlagsgesetz für Atmosphärische Luft). Dr. B. Walter. Discussing electric discharges through dielectrics, and giving tables showing the voltages required to overcome the resistance of various distances in air. 2000 w. Elektrotech Zeitschr—Oct. 6, 1904. No. 65743 B.

GENERATING STATIONS.

Commutation.

Commutation of Continuous-Current Generators and Motors. G. A. Neild and P. E. Banting. Read before the Rugby Engng Soc. Deals only with machines having slot-wound armatures and carbon brushes. Discusses the effect of weakening the fields of dynamos and motors, reactance voltage, crane motors, and errors of construction. Ills. 5500 w. Elec Engr, Lond—Sept. 23, 1904. No. 65443 A.

Generators.

The Design of Generators for Electric Power Transmission Work. David B. Rushmore. An explanation of the characteristics and relations of this machine. 5500 w. Eng News—Oct. 27, 1904. No. 65811.

Germany.

The Altbach Deizisau Central Station. Dr. Alfred Gradenwitz. Illustrated description of an installation supplying power and light to numerous towns of the Neckar and Fils Valleys in Southern Germany. 2500 w. Elec Rev, N Y—Oct. 22, 1904. No. 65664.

Hydro-Electric.

The Etzel Power Station (Von Etzelwerk). An account of the proposed hydro-electric station on the Upper Sihl near Zürich, with topographical map, and estimates of cost. 1500 w. Schweiz Bauzeitung—Oct. 1, 1904. No. 65768 B.

The Puyallup River Water Power Development Near Tacoma, Washington. Illustrated detailed description of a generating plant to supply electric power to the cities of Seattle and Tacoma, Wash. 6000 w. Eng News—Sept. 29, 1904. No. 65370.

The Works of the Ontario Power Company of Niagara Falls. Illustrated detailed description of a plant on the Canadian side of the river, planned for at least 180,000 h. p. ultimate capacity. 2700 w. Eng Rec—Oct. 8, 1904. Serial. 1st part. No. 65463.

See also Street and Electric Railways.

London.

The Lot's Road Generating Station of the Underground Electric Railways Co. of London. Illustrated description of the largest station of its kind in Great Britain. 3500 w. Elect'n, Lond—Oct. 21, 1904. No. 65845 A.

Power Station.

Largest Steam-Driven Power Station in the World. Illustrates and describes the steam plant of the New York Interborough Rapid Transit Company. 6700 w. Am. Elect'n—Oct., 1904. No. 65432.

Power Plant of the Intramural Railway at the St. Louis Exposition. Detailed description with illustrations. 4500 w. Eng News—Oct. 13, 1904. No. 65542.

The Power House of the Subway Division, Interborough Rapid Transit Co., New York. An illustrated comprehensive description of this station. 5800 w. Eng Rec—Oct. 1, 1904. Serial. 1st part. No. 65421.

Storage Battery Plant.

The Toronto Railway Storage Battery. An illustrated description of the plant, with a statement of the advantages obtained. 1500 w. Can Elec News—Oct., 1904. No. 65644.

Transformers.

Experiments with a Transformer of High Capacity (Versuche mit einem Transformator Hoher Eigenkapacität). Leo Lichtenstein. Data and results of test with a special transformer of high electrostatic capacity in the secondary. 2500 w. Elektrotech Zeitschr—Oct. 6, 1904. No. 65741 B.

Operation of the Series Transformer. Edward L. Wilder, in the *Electric Club Journal*. An explanation of the operation, and the difference between the series and the shunt. 1000 w. Elec Rev, N Y—Oct. 1, 1904. No. 65400.

Transformer Testing for Central Stations. S. E. Johanneson. Gives the various tests which may be applied to transformers. Diagrams. 2300 w. Engr, U S A—Oct. 1, 1904. Serial. 1st part. No. 65426 C.

Turbo-Generators.

An Interesting French Steam-Driven Turbine Plant. An illustrated detailed description of the power station of Neuchatel. 2800 w. Am Elect'n—Oct., 1904. No. 65431.

The 5,000-Horse-Power Three-Phase Turbo-Alternator at the Porta Volta Electric Supply Station of Milan. Illustrated description. 1000 w. Sci Am Sup—Oct. 1, 1904. No. 65388.

New Turbo-Generator Station of the Detroit Edison Company. Illustrates and describes a plant in which Curtis turbines are the prime movers, arranged to run either condensing or non-condensing. The plant is electrical throughout and strictly alternating-current. 3300 w. Engr, U S A—Oct. 1, 1904. No. 65424 C.

See Also Mechanical Engineering, Steam Engineering.

LIGHTING.

Illumination.

Street Lighting. A. S. Hatch. Read before the Int. Assn. of Munic. Elect'ns. Remarks on the various methods of electric lighting for streets. 3000 w. Munic Engng—Oct., 1904. No. 65375 C.

Nernst.

Tests of the Nernst Lamp by the Electric-Light Inspector of Hamburg (Untersuchungen an Nernstlampen seitens des Inspektorats der Elektrischen Beleuchtung in Hamburg). H. v. Gaisberg. With tables showing the life, current consumption, and illuminating power of the lamps tested. 1200 w. Elektrotech Zeitsch—Oct. 13, 1904. No. 65745 B.

Review.

Recent Progress in Electric Lighting (Récent Progrès de l'Eclairage Electrique). M. Roberjot. A review of recent improvements, including arc, mercury vapor, magnetite, incandescent, Nernst, and osmium lamps. 6000 w. Bull Soc d'Encour—Aug., 1904. No. 65754 G.

MEASUREMENT.

Chronograph.

A New Electro-Chronograph. David Owen. Brief, illustrated description. 900 w. Elect'n, Lond—Sept. 30, 1904. No. 65524 A.

Magnetograph.

A Quartz-Thread Vertical Force Magnetograph. W. Watson. An illustrated description of an instrument for recording rapid vibrations of vertical force, which has been actually run for some time. 2500 w. Sci Am Sup—Oct. 8, 1904. No. 65485.

Oscillograph.

Some Applications of the Oscillograph

(Einige Anwendungen des Oscillographen). Prof. Franz Wittman. Describing the use of the instrument for observing electric and magnetic waves and cycles. 4000 w. Elektrotech Zeitschr—Oct. 13, 1904. No. 65746 B.

Photometers.

On the Theory of the Matthews and the Russell-Léonard Photometers for the Measurement of Mean Spherical and Mean Hemispherical Intensities. Edward P. Hyde. A brief résumé of a theoretical investigation of the Matthews and the more recent Russell-Léonard integrating photometers. 1800 w. Elec Wld & Engr—Oct. 22, 1904. No. 65679.

Resistance.

The Thiermann Resistance Coil and Compensator (Messdraht und Kompensator nach Prof. Wilhelm Thiermann, Hannover). Dr. Wilhelm Schüppel. Describing an improved apparatus for comparing resistances, claimed to give accurate results to six significant figures. 3000 w. Elektrotech Zeitschr—Sept. 29, 1904. No. 65739 B.

Solenoids.

Cores for Solenoids (Ueber Solenoid-Kerne). F. G. Pero. Discussing the construction of solenoids for use in connection with electrical measuring instruments, including the best form and choice of material. 1200 w. Zeitschr f Elektrotechnik —Oct. 9, 1904. No. 65758 D.

Testing.

Notes on Testing. M. A. Sammett. Calls attention to the importance of temperature rise of apparatus under load. 1800 w. Can Elec News—Oct., 1904. No. 65645.

MOTORS.

Alternating Motors.

Alternating Current Commutator Motors. A. S. M'Allister. Reviews the properties common to all commutator type, alternating-current machines, and discusses the performance of repulsion motors. 3300 w. Sib Jour of Engng—Oct., 1904. No. 65671 C.

Design.

Design and Construction of Small Dynamos and Motors. Cecil P. Poole. The first of a series of articles aiming to enable amateurs to build any size of direct-current dynamos or motor, from 3 inches to 16 inches armature diameter without the necessity of mastering the science of dynamo design. 1000 w. Am Elect'n—Oct., 1904. Serial. 1st part. No. 65433.

Induction Motors.

The Computation of the Lines of Magnetic Force in Induction Motors (Die Berechnung der Streuung und des Magnetisierungsstromes von Drehstrommotoren). Dr. G. Benischke. Deriving general formulas applicable to any case without involving the use of empirical coefficients obtained from special experiments. 4000 w. Elektrotech Zeitschr—Sept. 22, 1904. No. 65737 B.

The Design of Induction Motors. A. Press. A mathematical investigation. 1000 w. Elec Rev, Lond—Oct. 14, 1904. No. 65689 A.

The Starting of the Heyland Single-Phase Induction Motor. A. Boyd. Describes experiments carried out with the object of showing the distribution of the flux in the air-gap before and after the rotor circuits are closed, and to explain how the latter distribution is brought so that a torque is produced in a definite direction. 3500 w. Elect'n, Lond—Sept. 23, 1904. No. 65448 A.

Railway Motor.

Exhibition of the General Electric Company's Compensated Railway Motor Equipment. Gives illustrations showing features of this new equipment recently exhibited on the Ballston extension of the Schenectady Railway. The object is to adapt electric traction to longer lines through the use of the alternating current. 1200 w. Am Mach—Vol. 27, No. 39. No. 65359.

Regulation.

The Speed Regulation of Three-Phase Motors by Pole Changing. J. K. Sumec. Abridged translation from the *Zeitschrift für Elektrotechnik.* Discusses the regulation of induction motors by varying the magnetic field. Diagrams. 1200 w. Elec Engr, Lond—Oct. 7, 1904. No. 65585 A.

Single Phase.

The Theory of the Single-Phase Non-Synchronous Motor (Zur Theorie des Asynchronen Einphasenmotors). Paul Müller. A mathematical and graphical study for different arrangements of the magnetic field. 4500 w. Electrotech Zeitschr—Sept. 29, 1904. No. 65740 B.

Starting.

Notes on Motor-Starting Switches. Considers the requirements of a good starting switch, and begins a detailed study of the construction of some of the higher-class starters used for special purposes. 4000 w. Elec Engr, Lond—Oct. 7, 1904. Serial. 1st part. No. 65582 A.

Synchronous Motors.

Discussion on "Synchronous Motors for the Regulation of Power-Factor and Line Voltage." Discussion at Chicago of paper by B. G. Lamme. 6500 w. Trans Am Inst of Elec Engrs—Oct., 1904. No. 65611 D.

TRANSMISSION.

Cable Losses.

On the Heating of Three-Phase Cable

Sheaths. M. B. Field. A discussion of the rotating field surrounding a three-phase cable, showing the existence of a torque between the conductors and sheath, with consequent losses. 2000 w. Elec Rev, Lond—Sept. 23, 1904. No. 65445 A.

Direct Current.

Direct Current Transmission at 70,000 volts. A. Steens. An account of interesting experiments recently carried out by the Compagnie de l'Industrial Electrique at Mécanique of Geneva, with a view to ascertaining the extent to which insulators would withstand the direct current as compared with alternating current. 2500 w. Elec Rev, Lond—Oct. 14, 1904. No. 65687 A.

Experiments with Continuous Currents at High Tensions (Expériences sur les Courants Continus à Haute Tension). An account of experiments at Geneva with the transmission of continuous currents at pressures as high as 70,000 volts. 1500 w. Genie Civil—Sept. 17, 1904. No. 65717 D.

High Tension.

High-Tension Lines. H. Parker Gibbs. On the importance of good line construction, and other points essential for successful working. Ills. 2800 w. Elec Rev, N Y—Oct. 22, 1904. No. 65663.

Lightning Arresters.

Protection from Lightning. Prof. Dr. Fr. Neesen. A lecture delivered before the Electrochemical Society of Leipzig. An illustrated review of the laws governing the construction of lightning protectors. Considers protectors for buildings, arresters for low-potential circuits, and for high-potential circuits. 3800 w. Sci Am Sup—Oct. 22, 1904. No. 65643.

Long Spans.

Discussion on "Long Spans for Transmission Lines." Discussion at Chicago of the paper by F. O. Blackwell. 9500 w. Trans Am Inst of Elec Engrs—Oct., 1904. No. 65610 D.

Norway.

The Electric Power-Transmission Plant at the Waterfalls of Kykkelsrud, Norway. Einar Boye. Illustrated detailed description. 2500 w. Elec Rev, N Y—Oct. 1, 1904. No. 65399.

Three-Phase.

The Three-Phase 40,000-Volt Power Transmission from Gromo to Nembro (Lombardia). States the conditions which had to be fulfilled and gives an illustrated description of the carrying out of the scheme, with reasons for the adoption of an extra high working pressure. 5400 w. Elec Rev, Lond—Sept. 23, 1904. No. 65446 A.

MISCELLANY.

Address.

President's Address. Bion J. Arnold. Address at the St. Louis meeting discussing how to determine the dividing line between steam and electricity in railway operation. 3300 w. Trans Am Inst of Elec Engrs—Oct., 1904. No. 65609 D.

Electrical Law.

Electrical Law in the Colonies and India. Synoposis of electrical legislation in the more important British colonies. 3000 w. Elec Rev, Lond—Sept. 30, 1904. Serial. 1st part. No. 65523 A.

Electrical Legislation. W. Valentine Ball. A discussion of the effect of British legislation upon the electrical industry, and the effort being made to bring about a reform. 3800 w. Trac & Trans—Oct., 1904. No. 65534 E.

INDUSTRIAL ECONOMY

Education.

A New Departure in Technical Education. E. H. Roberton. Brief, illustrated description of the experimental mine at Birmingham University. 900 w. Page's Mag—Oct., 1904. No. 65567 B.

Notes on Engineering Education (Considérations sur l'Enseignement de la Mécanique). Prof. J. Boulvin. A discussion of the importance of combining practical with theoretical training in the education of the engineer. Serial. Part I. 4000 w. Revue de Mécanique—Sept., 1904. No. 65731 E + F.

Notes on the Technical Intermediate Schools (Betrachtungen über technische Mittelschulen). Adolf Lippmann. A review of the curriculum of the preparatory school, discussing the work of private institutions in Germany. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Oct .1, 1904. No. 65711 D.

Technical Education in the United States. P. Krenzpointner. Translated from *Zeitschrift des Vereines Deutscher Ingenieure*. A general review of the educational system of the country. 3000 w. Bul Int Ry Cong—Sept., 1904. No. 65620 E

Labor.

Application of Scientific Methods to the Labor Problem. H. L. Gantt. Read before the Int. Cong. of Arts and Sciences at St. Louis. Reviews briefly the development of the manufacturing industries, and suggestions for a scientific study of the proper amount of work to be required in a day, and the compensation. 2300 w. Am Mach—Oct. 20, 1904. No. 65630.

Laboratory.

The Mechanical Plant of the New Technical High School at Danzig (Die Maschinenanlagen der Neuen Technischen Hochschule zu Danzig). W. Josse. A very full account of the new plant of the mechanical laboratory, including steam, hydraulic, pneumatic and electrical equipment. 10,000 w. 2 plates. Zeitschr d Ver Deutscher Ing—Oct. 8, 1904. No. 65713 D.

Patent Rights.

The Patent Rights of Employers and Workmen. Discusses how far an inventor is entitled to claim the fruits of the workman's labor and ingenuity, stating several cases in their legal aspect. 3500 w. Engr, Lond—Sept. 30, 1904. No. 65528 A.

Statistics.

An Engineering Problem (Eine Ingenieuraufgabe). H .Häbich. A discussion of the industrial problems in connection with manufacturing in various countries, dealing especially with the effect of American competition with Germany. 4500 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1904. No. 65704 D.

MARINE AND NAVAL ENGINEERING

Arctic Service.

Peary's New Ship for Work in Arctic Seas. An illustrated description of this specially constructed vessel, designed to meet every emergency of the Arctic climate. 1500 w. Sci Am—Oct. 8, 1904. No. 65482.

Battleships.

H. M. S. Black Prince. Illustration, with description, and comparison with the French Renan and the U. S. A. California. 800 w. Engr, Lond—Oct. 14, 1904. No. 65698 A.

Italian First-Class Battleship "Regina Margherita." Illustration, with description. Also gives one of the engines. 700 w. Sci Am Sup—Oct. 8, 1904. No. 65483.

Machinery of the Italian Battleship Regina Margherita. Description, with illustrations and report of trials. 1600 w. Marine Engng—Oct., 1904. No. 65407 C.

Cruiser.

The Japanese Armored Cruiser "Kasuga." Illustrations, with comments. 500 w. Engng—Oct. 21, 1904. No. 65838 A.

Fleet Auxiliaries.

Auxiliaries of a War Fleet with Special Reference to Recent Additions to the British Navy. Archibald S. Hurd. Shows the necessity of providing for this service and gives particulars of the more important recent types added to the British Navy. 5000 w. Cassier's Mag—Oct., 1904. No. 65347 B.

Gas Power.

See Mechanical Engineering, Internal-Combustion Motors.

Launch.

Launch of Battleships Connecticut and Louisiana. Illustrations, with brief descriptions and information of interest. 700 w. Marine Engng—Oct., 1904. No. 65408 C.

The Launching of the United States Battleship Connecticut. Illustrated description of this vessel and her equipment, with details of the contest between the work in the government navy yard and on a sister ship in a private shipbuilding establishment. 3700 w. Ir Age—Oct. 6, 1904. No. 65467.

Launch Motor.

See Mechanical Engineering, Internal-Combustion Motors.

Lifeboats.

Some New Types of Lifeboats. An illustrated article describing the adaptation of the gasoline motor to the requirements of lifeboat work. Also describes the boat invented by M. Albert Henry. 3800 w. Sci Am—Oct. 8, 1904. No. 65481.

Liquid Fuel.

See Mechanical Engineering, Steam Engineering.

Schooner.

Pacific Coast Steam Schooner Likelike. Illustrated detailed description. 1200 w. Marine Engng—Oct., 1904. No. 65410 C.

Shipbuilding.

Messrs. Beardmore's New Shipyard and Engine Works. Illustrated description of fine new works on an ideal site on the River Clyde, and their equipment. 5000 w. Engng—Oct. 7, 1904. No. 65570 A.

The Slips of the Vulcan Works at Stettin (Die Hellinge der Stettiner Maschinenbau, A. G. Vulcan). A description of the ways and overhead travelling crane equipment over the shipbuilding slips at the Vulcan Works. 1800 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1904. No. 65710 D.

Steamship.

The Freight and Passenger Steamer Prince Sigismund (Der Fracht und Personendampfer "Prinz Sigismund"). W. Kaemmerer. Illustrating and describing a new vessel built for the South American trade of the Hamburg-American Line. 1200 w. 1 plate. Zeitschr d Ver Deutscher Ing—Sept. 24, 1904. No. 65706 D.

Torpedo Explosions.

The Effect of Torpedo Explosions. Interesting illustrations of a Japanese vessel torpedoed and left to sink, but finally saved, with brief notes. 400 w. Engng—Oct. 7, 1904. No. 65572 A.

Tugboats.

Economic and Earning Possibilities of the Ocean-Going Tugboat. Discusses briefly the development and improvements in towboats, and the probability of their being used more extensively for coast service. 1800 w. Naut Gaz—Oct. 6, 1904. No. 65497.

Tugboats and Towing in the United States. Illustrates types of boats used on harbors, lakes and rivers, and reviews the history of this indusry. 1800 w. Naut Gaz —Oct. 6, 1904. No. 65496.

Turbine Propulsion.

How the Victorian Looks. Illustrations, with description of this turbine vessel built for service on the Atlantic, in the Candian mail service. 2300 w. Marine Rev—Sept. 29, 1904. No. 65406.

The First Turbine Atlantic Liner. An illustrated description of the "Victorian," the first of two turbine-driven ships ordered by the Allan Line. 1100 w. Page's Mag—Oct., 1904. No. 65568 B.

Yacht.

The Auxiliary Power Yacht "Mollihawk II." Illustrates and describes two vessels in which the sail and power systems of propulsion are combined. They are fitted with oil engines. 2000 w. Engng —Oct. 7, 1904. No. 65571 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air-Cooling.

Progress of the Air-Cooled Motor. C. C. Longridge. Reviews the present disabilities of the air-cooled high-powered motor, and discusses the progress that has been made. 2000 w. Engr, Lond—Sept. 30, 1904. No. 65530 A.

Commercial Vehicles.

The Milnes-Daimler Omnibuses and Commercial Vehicles. Begins an illustrated description of this class of vehicles, as designed by the company named. 1100 w. Auto Jour—Sept. 24, 1904. Serial. 1st part. No. 65438 A.

Cup Race.

First Competition for the Vanderbilt International Automobile Cup. An illustrated account of the recent race on Long Island. 2200 w. Sci Am—Oct. 22, 1904. No. 65642.

How the Vanderbilt Cup Race Was Won. A number of articles giving illustrated detailed accounts of the first race for the Vanderbilt Cup, won by a Panhard racer for France. 30700 w. Automobile—Oct. 15, 1904. No. 65559.

Electric Vehicles.

Costs of Electric Automobilism. Robert H. Smith. A discussion of the cost of running these vehicles, giving experience in London, and giving the conclusions of the writer. 2300 w. Engr, Lond—Sept. 30, 1904. No. 65527 A.

Gordon-Bennett Cup.

The Gordon-Bennett Cup for 1905. States propositions of Marquis de Dion for changes in the rules for this international championship, with opinions of French and British. 2000 w. Autocar—Oct. 15, 1904. No. 65680 A.

Headlights.

Headlights and Night Driving. Joseph Tracy. Suggestions and cautions. 1000 w. Automobile—Oct. 1, 1904. No. 65392.

Martini.

The 16-20 h. p. Martini. Illustrated description of one of the cars used by Captain Deady in his recent Alpine tour. 1500 w. Autocar—Oct. 8, 1904. No. 65587 A.

Rebuilding.

Rebuilding an Early Winton. A. Wilson Dods. An account of how the writer rebuilt Winton No. 61. Ills. 1200 w. Automobile—Oct. 1, 1904. No. 65391.

Speed Changing.

The Sturtevant: A Car with Automatic Change-Speed. Illustrated detailed description of a new gasoline automobile with novel features of exceptional interest. 2300 w. Automobile—Oct. 8, 1904. No. 65499.

Speed Indicators.

Speed Indicators for Automobiles. Illustrates and describes new types. 2500 w. Auto Jour—Oct. 15, 1904. Serial. 1st part. No. 65681 A.

Steam Wagon.

The Pyrodyen Steam Wagon. Illustrated description of a steam wagon to carry a load of 7½ tons. The fuel used is petroleum oil of the cheapest kind. 1000 w. Engr, Lond—Oct. 21, 1904. No. 65843 A.

Steel Specialties.

Automobile Steel Specialties. George E. Walsh. On the amount of steel used for this industry, the quality, tests, &c. 1200 w. Sci Am—Oct. 15, 1904. No. 65544.

HEATING AND COOLING.

Heat Loss.

Some Experiments on Loss of Heat from Iron Pipes. R. W. Leonard. Gives results of experimental investigations. 1000 w. Can Soc of Civ Engrs, Adv. Proof—Oct., 1904. No. 65817 D.

Hot Water.

Heating by Hot Water (Chauffage à Eau Chaude). A. Monteilhet. With especial reference to the Rouquaud system of assisted circulation. 2000 w. Génie Civil—Sept. 24, 1904. No. 65719 D.

Humidification.

The Humidification of Textile Establishments (L'Humidification des Locaux de l'Industrie Textile). Paul Razous. A review of the artificial methods of maintaining the proper hygrometric state of the atmosphere for spinning and weaving operations. 2000 w. Génie Civil—Sept. 17, 1904. No. 65715 D.

Steam Heating.

A New System of Vacuum Return Line Exhaust Steam Circulation. James A. Donnelly. Read before the Modern Science Club, Brooklyn, N. Y. Reviews early patents, describing the Williames thermostatic or automatic system as now installed, and naming the disadvantages of these systems, suggesting remedies and describing new valves that will work well on the Williames system. Ills. 4000 w. Met Work—Oct. 8, 1904. No. 65454.

Ventilation.

The Ventilation of the Hotel Astor, New York. Description, with drawings, of an extensive equipment of fans and blowers for circulating air through the building. 3000 w. Eng Rec—Oct. 8, 1904. No. 65465.

HYDRAULICS.

Intensifiers.

Notes on the Design of Hydraulic Intensifiers. G. E. Flanagan. Illustrated description of a three-phase hydraulic intensifier, explaining also the two-stage, and single-stage apparatus. 700 w. Am Mach—Oct. 20, 1904. No. 65629.

Pelton Wheel.

The Pelton Water Wheel Equipment in the Puget Sound Power Company's Plant. George J. Henry, Jr. An illustrated detailed description. 2500 w. Jour of Elec—Oct., 1904. No. 65506 C.

Pneumatic Pumping.

Air Lift Pumps. W. H. Booth. Gives a brief description of the principle on which the air lift pump works, discussing its advantages and disadvantages. 2200 w. Elec Rev, Lond—Sept. 23, 1904. No. 65444 A.

The Installation of a Pneumatic Pumping Plant. Elmo G. Harris. Discussion of paper by Arthur H. Diamant, Jr. 2000 w. Pro Am Soc of Civ Engrs—Oct., 1904. No. 65824 E.

Pumps.

Motor Driven Pumps. W. H. Wakeman. Illustrates and describes pumps driven by electricity. 900 w. Elec, N. Y. —Oct. 12, 1904. Serial. 1st part. No. 65513.

Turbines.

The Regulation of Hydraulic Turbines (La Régulation des Turbines Hydrauliques). L. Ribourt. An examination of the action of various turbine governors, comparing the centrifugal type with the hydraulic cataract form. 6000 w. 3 plates. Mem Soc Ing Civ de France—July, 1904. No. 65734 G.

Water Wheels.

The Water Wheel. Sidney Russell. An illustrated historical review of the various types, and some of the applications. 8600 w. Trac & Trans—Oct., 1904. No. 65533 E.

INTERNAL COMBUSTION MOTORS.

Alcohol.

Alcohol for Motors. M. C. Krarup. Discusses the causes that have led to the use of alcohol in Europe, and also the merits of alcohol as a fuel, and its importance to engine builders. 2000 w. Am Mach—Vol. 27, No. 41. Serial. 1st part. No. 65540.

Gas Engines.

The Economy of Large Gas Engines. Remarks made by Dr. Edward Hopkinson, as a witness before the Royal Commission on coal supplies, dealing with the economy of fuel which may be anticipated from the use of large gas engines in the place of steam engines for driving dynamos. 2800 w. Mech Engr—Oct. 1, 1904. No. 65519 A.

The Gas Engines of the Société Française de Constructions Mécaniques (Moteurs à Gaz Construits par la Société Française de Constructions Mécaniques). Ch. Dantin. With drawings of engines, and a photograph of a 1,200 h. p. engine in course of erection. 2000 w. 1 plate. Génie Civil—Oct. 8, 1904. No. 65723 D.

Gas Power.

A Gas Engine Harbor Electric Plant. Illustrated description of interesting features in the plant of the Midland Railway Company at the new harbor in Morecambe Bay for the Isle of Man and Irish traffic. 3300 w. Elec Wld & Engr—Oct. 8, 1904. No. 65495.

Power Gas from Peat (Ueber Torfgas zum Motorbetrieb). E. Hubendick. An account of the successful use of peat for the production of gas for use in gas engines, in Sweden. 1200 w. Oesterr Zeitschr f Berg u Hüttenwesen—Sept. 24, 1904. No. 65759 D.

The Importance of Furnace Gases for Electric Traction (Die Bedeutung des Gichtgases für die Elektrische Traktion). O. Peter. A discussion of the availability of power from blast furnace gases for operating electric traction in the vicinity of iron works. Serial. Part I. 4000 w. Glasers Annalen—Oct. 1, 1904. No. 65751 D.

Gas Producers.

Gas Producers on Shipboard. Bernhard A. Sinn. Describes the suction gas producer, and gives an illustrated description of its installation on shipboard, with report of its operation. 2200 w. Marine Engng—Oct., 1904. No. 65409 C.

Launch Motor.

The Design of a Launch Motor. Edward Butler. Illustrated detailed description of a compound kerosene oil motor. 2700 w. Mech Engr—Sept. 24, 1904. Serial. 1st part. No. 65441 A.

Petroleum Motors.

Oil Engines. Gustave Ey. Read before the Engng. Assn. of N. S. W. An explanation of the Otto cycle, two-stroke cycle, carburetter and vaporizer, and igniters. Ills. 3000 w. Aust Min Stand—Sept. 1, 1904. No. 65439 B.

The Allsop Smokeless Petroleum Engine. Illustrates and describes an engine which uses common petroleum as a source of energy; runs without smoke or smell, and leaves no carbonaceous deposit in the cylinder. 1200 w. Autocar—Oct. 1, 1904. No. 65516 A.

Petrol Motors.

Horse-Power Computation for Petrol Motors. Capt. C. C. Longridge. Three motors are taken and various formulæ are stated and applied to determine which are of practical value. Piston displacement is also discussed, also horse-power charts. 1200 w. Engr, Lond—Oct. 7, 1904. No. 65576 A.

See also Mechanical Engng., Automobiles.

MACHINE WORKS AND FOUNDRIES.

Aligning.

A Handy Tool for Locating and Aligning Shafting and Machinery. William H. Brooks. An illustrated description of the tool and the principle of its operation. 1000 w. Eng Rec—Oct., 1904. No. 65429 C.

Balancing.

Balancing a Valve and Diaphragm. Jas. Clark. Gives the author's solution of the problem of finding the outside diameter of a diaphragm to balance a valve of 1¼ inches diameter of seat, both connected to the same stem, which was ½ inch diameter. 500 w. Am Mach—Vol. 27, No. 43. No. 65810.

Blowers.

Cupola Fan Practice. W. H. Carrier. Read at the A. F. A. Convention, 1904. Gives reliable data relative to the operation of centrifugal blowers for cupola service. 2800 w. Foundry—Oct., 1904. No. 65379.

Fan Blowers for Cupola Work. G. William Sangster. Read at the A. F. A. Convention, 1904. Notes on the principles of fan blowers. 1700 w. Foundry—Oct., 1904. No. 65380.

Brass Castings.

Casting Brass Liners on Propeller Shafting. A. Urquhart. Illustrates and describes the method of casting brass liners on propeller shafting. 800 w. Foundry—Oct., 1904. No. 65381.

Bronze Castings.

Williamsburg Bridge Tablets. Illustrated description of the making of these large tablets. 600 w. Foundry—Oct., 1904. No. 65377.

Case-Hardening.

Notes on Cementation. Georges Charpy. A report of experimental investigations and the results obtained. 2200 w. Ir & St Mag—Oct., 1904. No. 65612 D.

Castings.

Steel Castings. W. A. Herron. Briefly describes the several processes in use for making cast steel, the cleaning, inspection, &c. Discussion. 10000 w. Pro Ry Club of Pittsburg—Oct. 18, 1904. No. 65820 C.

Chilled Castings.

Bell Cranks and Small Chilled Castings. C. Neil. Illustrates and describes methods of molding. 700 w. Foundry—Oct., 1904. No. 65385.

Costs.

Percentage Method of Determining Production Costs. Harrington Emerson. Describes a percentage method of working from a basis of elementary labor and material costs. 1700 w. Foundry—Oct., 1904. No. 65383.

Cupolas.

Cupola Practice. Harry Willis. Describes practice in one of the best foundries in New Zealand. 1200 w. Foundry—Oct., 1904. No. 65382.

Electric Power.

Description of the Electrical Equipment of an Engine Works and Shipyard, with Notes Thereon. H. O. Wraith. Read before the Leeds Local Sec. of the Inst. of Elec. Engrs. Discusses the question of converting large works of this type to electric driving. 4500 w. Elec Engr, Lond—Oct. 14, 1904. Serial. 1st part. No. 65685 A.

Factory.

Organization of the Remington Typewriter Factory at Ilion, N. Y. John Calder. An explanation of the organization of a factory which can employ 2,000 people. 2000 w. Ir Trd Rev—Oct. 6, 1904. No. 65486.

Foundry.

The New Foundry of the Hilles & Jones Company. Illustrated description of a new foundry at Wilmington, Del. The walls are of concrete to a height of 14 ft., and are of glass set in iron framework the remainder of the distance to the roof. 3000 w. Ir Age—Oct. 13, 1904. No. 65537.

Gages.

The Grinding of Thread Gages. J. R. Gordon. Describes the different operations the writer has used in making these tools. 1200 w. Mach, N. Y.—Oct., 1904. No. 65430 C.

Grinding.

Some New Cutter and Tool-Grinding Machinery. Charles S. Gingrich. Illustrated detailed descriptions of examples from American practice. 4000 w. Cassier's Mag—Oct., 1904. No. 65349 B.

Hardening.

Experiences and observations in Hardening Tools. From the *Zeitschrift fuer Werkzeugmaschinen und Werkzeuge.* Gives results obtained from a series of experiments to find the best hardening temperature for different kinds of steel. 2000 w. Am Mach—Sept. 29, 1904. No. 65360.

Inspection.

The Practical Inspector. E. N. Percy. Suggestions on inspection of materials. 2000 w. Mach, N. Y.—Oct., 1904. No. 65428 C.

Locomotive Works.

New Locomotive Works in Canada. Illustrated description of the recently built works of the Locomotive and Machine Company of Montreal, Limited. 900 w. Engr, Lond—Sept. 30, 1904. No. 65529 A.

Machine Shop.

The New Cail Shops at Denain (Les Nouvelles Usines Cail à Denain). Ch. Dantin. A fully illustrated account of the new shops of the Société Français de Constructions Mécaniques, successors to the old firm of Cail & Co. Two articles, two plates. 5000 w. Génie Civil—Sept. 24, Oct. 1, 1904. No. 65718 each D.

Melting.

Cost of Melting in an Oil Furnace. James F. Webb. Claims that there is a saving in melting brass in the Rotary furnace. 700 w. Foundry—Oct., 1904. No. 65376.

Molding.

Molding Machine Practice. F. W. Hall. Illustrated description of the arranging of a ratchet wheel on a molding machine. 1800 w. Foundry—Oct., 1904. No. 65384.

Oil Fuel.

Economy and Advantage of Oil Fuel for Forging. Extract from a paper by S. Uren, to the Nat. R. R. Master Blacksmiths' Ass'n. Gives a comparison of the cost of coal and oil in the smith shop. 1500 w. Ry & Engng Rev—Oct. 1, 1904. No. 65415.

Planers.

Important Improvements in Planer Design. Illustrates and describes some recent planers which show that some very radical changes in design have been made with surprising results. 2000 w. Am Engr & R R Jour—Oct., 1904. No. 65414 C.

Rolling Mill.

The Friedenshütte Rolling Mill (Trägerwalzwerk der Friedenshütte). Fr. Frölich. Illustrated description of recent mills for rolling beams and structural shapes, at the Friendenshütte, in Upper Silesia. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1904. No. 65700 D.

Sand Blast.

A New Sand-Blast Apparatus. Francis Sticker. Illustrated detailed description of the apparatus. 2000 w. Am Mach—Vol. 27, No. 41. No. 65539.

Screws.

The Geometry of the Square-Thread Screw. Ferdinand Peam. Indicates how screws and nuts of low helix angle may be made a commercially perfect fit. Ills. 3000 w. Am Mach—Vol. 27, No. 43. No. 05809.

Screw Threads.

The Unification of Screw Threads (Unification des Filetages). A discussion of the standardization of metric screw threads for small screws, less than six millimetres in diameter. 6000 w. Bull Soc d'Encour—Sept., 1904. No. 65729 G.

Shop Methods.

A Development of Recent Machine Shop Processes. W. M. Barr. A review of methods of producing interchangeable work in the general shop, with especial reference to marine-engine work. 3000 w. Engineering Magazine—Nov., 1904. No. 65779 B.

Shop Records.

Report of the Joint Committee of the American Railway Mechanical & Electrical Association and the Street Railway Accountants' Association of America on Blanks for Shop Records and Accounts. 3300 w. St Ry Jour—Oct. 15, 1904. No. 65603 C.

Shrinkage.

Shrinkage Troubles and Methods of "Feeding." Thomas D. West. Read before the New England Found. Assn. Discusses the different methods that may be employed to prevent shrinkage. 2500 w. Ir Trd Rev—Oct. 20, 1904. No. 65646.

Stores.

Stores Arrangement as a Factor in Shop Management. John Ashford. The second article discusses the practical details of execution of a stores system; with illustrations from various important shops. 3000 w. Engineering Magazine—Nov., 1904. No. 65774 B.

Tubes.

Weldless Tubing (Tubes sans Soudure). L. Joubert. A discussion of the methods of making seamless tubing of iron or steel, including the practice in France, England, Sweden, and Germany. 7500 w. 1 Plate. Mem Soc Ing Civ de France—July, 1904. No. 65733 G.

Type-Founding.

Early Methods of Type-Founding. A brief history of the evolution of the type-mould as brought out by the researches of J. Eliot Hodgkin. Ills. 4600 w. Engng —Oct. 14, 1904. No. 65691 A.

Westinghouse.

The Pittsburg Works of the Westinghouse Company. John R. Hewett. Illustrated detailed description of the large works at East Pittsburg, Pennsylvania. 10000 w. Trac & Trans—Oct., 1904. No. 65532 E.

Works Administration.

Obsolete Methods and Current Practice in Works Administration. Egbert P. Watson. A review of past practice, comparing it with modern systems. 3000 w. Engineering Magazine—Nov., 1904. No. 65776 B.

MATERIALS OF CONSTRUCTION.

Cast Iron.

Some Phenomena in the Shrinkage of Cast Iron. Thomas D. West. A study of the shrinkage question presenting facts of interest and suggesting ideas for valuable research. 1000 w. Ir & St Mag—Oct., 1904. No. 65613 D.

Lubricants.

Mineral Lubricating Oils. J. N. Bruck. Gives some historical facts relating to petroleum; considers its refining, gravity and fire tests, and concludes that the mineral oil which has the greatest adhesion to metallic surfaces, and the least cohesion between its own particles, is the best lubricant. 3000 w. Aust Min Stand—Sept. 1, 1904. No. 65440 B.

Manganese.

Use of Manganese in the Cupola or the Ladle. N. W. Shed. An account of experiments made to determine whether it makes any difference in the castings whether the manganese is added to the cupola or to the ladle. Gives results. 1100 w. Foundry—Oct., 1904. No. 65378.

Metals.

Surface Flow and the Hard and Soft State in Metals. Reviews the researches of Mr. G. T. Beilby, of Glasgow, on surface flow and the hard and soft conditions of metals, which are of considerable practical importance. 3000 w. Engng—Oct. 7, 1904. No. 65573 A.

Protective Coatings.

Sherardizing. Illustrates and describes a new process, invented by Sherard Cowper-Coles, for protecting iron and steel from corrosion. 2200 w. Ir Age—Oct. 20, 1904. No. 65633.

Steels.

Investigations upon Steels Containing Titanium and Tin (Recherches sur les Aciers au Titane et à l'Etain). Léon Guillet. Giving results of mechanical and metallographical tests of various carbon content, alloyed with titanium and with tin. 1800 w. Génie Civil—Sept. 17, 1904. No. 65716 D.

Properties, Classification, and Utilization of Special Ternary Steels (Propriétés, Classification et Utilisation des Aciers Spéciaux Ternaires). L. Guillet. A discussion of alloy steels composed of iron, carbon, and one other metal, stating briefly the qualities of steels containing nickel, manganese, chromium, tungsten, molybdenum, vanadium, silicium, titanium, aluminum, cobalt, and tin. 12000 w. 1 plate. Mem Soc Ing Civ de France—July, 1904. No. 65735 G.

The Constitution and Properties of Tungsten Steels (Constitution et Propriétés des Aciers au Tungstène). Léon Guillet. Results of chemical and metallographical investigations of steels of various contents of carbon and tungsten, showing the conditions existing in tempering and air hardening. 1000 w. Comptes Rendus—Sept. 26, 1904. No. 65749 B.

The Properties and Constitution of Molybdenum Steels (Propriétés et Constitution des Aciers au Molybdène). Léon Guillet. Experiments upon steels with various proportions of molybdenum, showing the strength, hardening, and tempering properties. 800 w. Comptes Rendus—Oct. 3, 1904. No. 65750 B.

Structural Steel.

The Fracture of Structural Steel Under Alternating Stresses. Prof. John O. Arnold. Read before the British Assn. Gives facts learned by experimental investigations covering two years. Ills. 1300 w. Mech Engr—Sept. 24, 1904. No. 65442 A.

Tempering.

Notes on the Tempering of Steel (Etudes sur la Trempe de l'Acier). Henry le Chatelier. A study of the effect of temperature, contact, composition, dimensions and manipulation upon the tempering of steel. 8000 w. Rev de Metallurgie, Bull Soc d'Encour—Sept., 1904. No. 65730 G.

Testing.

A New Method of Testing Metals (Une Nouvelle Méthode d'Essais Mécaniques des Métaux). M. Guillery. The hardness is determined by Brinell's method, the elastic limit by the change in the appearance of a polished surface, and the brittleness by the fracture of a nicked bar in a special apparatus. 5000 w. Rev de Metallurgie, Bull Soc d'Encour—Aug., 1904. No. 65755 G.

Tool Steel.

The Development and Use of High-Speed Tool Steel. J. M. Gledhill. On the development and thermal treatment of high-speed steel, referring to its practical use and some of the most recent work done with it. Ills. 12000 w. Iron & Steel Inst—Oct., 1904. No. 65803 D.

The Practical Handling of High Speed Steel. Gives general principles applicable to most of the rapid cutting steels. 1500 w. Ir Age—Oct. 6, 1904. No. 65468.

MEASUREMENT.

Barometer.

The Construction of an Indicating or Recording Tin Plate Aneroid Barometer. N. Monroe Hopkins. Illustrates and describes the construction of a very successful aneroid barometer out of simple tin plates. 2700 w. Sci Am Sup—Oct. 1, 1904. No. 65389.

Centrifugal Force.

Radial Stresses Due to Centrifugal Force in Revolving Bodies. A. M. Levin. A mathematical study to determine to what extent the material will be strained, and what form would ensure the greatest strength. 2500 w. Am Mach—Vol. 27, No. 42. No. 65628.

Inertia.

Determination of the Moment of Inertia of Parallel Forces in One Plane (Die Bestimmung des Trägheitsmomentes Paralleler in derselben Ebene Liegender Kräfte). Nikolaus von Szüts. Showing the application of the graphical method to the solution of the problem. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Sept. 23, 1904. No. 65726 D.

Metric System.

The Metric System in Mechanical and Electrical Engineering. Read before the Rugby Engng. Soc. I. Introductory Statement for the Metric System. Ernest R. Briggs. II. Reply to the Introductory Statement. R. C. Jackson. Also editorial. 5000 w. Elec Engr, Lond—Oct. 14, 1904. No. 65686 A.

Stresses.

Stresses in Thin Cylinders Subjected to Internal Pressure. A. T. Weston. Gives a brief description of a method of dealing with this problem in its most general form, and points out the direction in which its practical applications will lie. 1800 w. Engr, Lond—Sept. 23, 1904. No. 65452 A.

POWER AND TRANSMISSION.

Conveying.

Coal-Conveying Plant at a Manchester Power Station. Illustrated description of the coal and ash-handling arrangements. 1000 w. Engr, Lond—Oct. 7, 1904. No. 65579 A.

Tepherage. C. J. Messer. An illustrated article on the value of electric propulsion applied to aerial transportation of materials, describing several interesting installations. 4500 w. Jour Fr Inst—Oct., 1904. No. 65436 D.

Elevators.

Hydraulic Plunger Elevators. William Baxter, Jr. An illustrated detailed description of this type and its working. 3000 w. Engr, U S A—Oct. 15, 1904. No. 65606 C.

Modern Elevator Types and Elevator Practice. H. S. Knowlton. Describing especially the later electric and hydraulic systems. 3500 w. Engineering Magazine—Nov., 1904. No. 65778 B.

Mechanical Handling.

Modern Appliances for the Economical Handling of Material. Henry E. P. Cottrell. Describes and illustrates modern grabs, excavators, &c., and the work they accomplish. 5700 w. Engng Rev—Oct., 1904. No. 65569 B.

Special Transport Appliances in Modern Machine Works (Spezial Konstruktionen Moderner Transportmittel für Hüttenwerke). Illustrating furnace-charging machines, traveling cranes, and special appliances for handling ingots, etc. Three articles. 8000 w. Stahl u Eisen—Sept. 15, Oct. 1, 15, 1904. No. 65769 each D.

Power.

Gas, Oil and Steam for Power. Michael Longridge. Lecture delivered before the British Assn. of Mgrs. of Textile Works. Restricts the paper to the consideration of steam, gas, and oil engines as heat engines. 3500 w. Engr, Lond—Oct. 14, 1904. Serial. 1st part. No. 65800 A.

Speed Changes.

Calculating Cone Steps and Back-Gearing Ratios by the Slide Rule. W. Owen. Deals with the application of the slide rule to calculations necessary in designing machine tools. 1000 w. Am Mach—Oct. 20, 1904. No. 65631.

STEAM ENGINEERING.

Boiler-Feed.

Air in Relation to Boiler-Feeds. Jas. Alex. Smith. Read before the Victorian Inst. of Engrs., at Melbourne. A record of data derived from original observations referring to the absorption by comparatively pure water of atmospheric components, and the effects in relation to some engineering problems. 2500 w. Engng—Oct. 7, 1904. No. 65575 A.

The Use of Soda Ash in Locomotive Tanks. S. K. Dickerson. Discusses points of importance in using soda ash, and claims that when properly used it increases the life of the flues, gives less trouble from leaky flues, stay bolts, seams, &c. Ills. 1700 w. Pro Cent Ry Club—Sept., 1904. No. 65621 C.

Boilers.

The Care of Locomotive Boilers. M. E. Wells. Discussion of this subject from the conclusion that it is inequality of temperature which causes most boiler troubles. 1200 w. Ry Age—Oct. 21, 1904. Serial. 1st part. No. 65660.

The Dürr Water-Tube Marine Boiler (Wasserrohr Schiffskessel, System Dürr). The design includes inclined water tubes, with interior circulating tubes, and overhead steam drum. 1800 w. Glasers Annalen—Oct. 1, 1904. No. 65753 D.

Boiler Tests.

Evaporative Tests of Lancashire Boilers. William D. Hamilton. Describes tests carried out for the purpose of demonstrating a guarantee that each boiler would evaporate 10,000 lbs. of water per hour from a feed-water temperature of 240 deg. Fah. with rough small steam coal after it had passed through a mesh ¾ in. diameter. 3300 w. Prac Engr—Oct. 14, 1904. No. 65684 A.

Chimneys.

Chimney Action. W. H. Booth. Discusses the efficiency of chimneys, their working, draught, &c. 3000 w. Elec Rev, Lond—Oct. 14, 1904. No. 65688 A.

Condensation.

Condensing Plant. W. H. Booth. Illustrates and describes types of British condensers and accessories. 5000 w. Cassier's Mag—Oct., 1904. Serial. 1st part. No. 65348 B.

Draft.

Mechanical Draft for Boilers. Abstract of a paper read by W. Yates, of Liverpool, before the Inst. of Heat. and Vent. Engrs. Remarks on the combustion of fuel, and the best means of producing the requisite draft, discussing forms of mechanical draught. Ills. 2000 w. Prac Engr—Sept. 30, 1904. Serial. 1st part. No. 65518 A.

Engines.

Corliss Engine Design. L. L. Willard. The first of a series of illustrated articles aiming to show how these engines are being built, and how to proportion the parts to secure the best results at a reasonable cost. 1200 w. Engr, U S A—Oct. 1, 1904. Serial. 1st part. No. 65425 C.

Design of High-Speed Enclosed Steam Engines. An illustrated series of articles dealing with some of the main points to be considered in the design of the details, and mentioning some of the difficulties. Shows the development of the high-speed engine as used for electric lighting and traction. 2800 w. Engr, Lond—Oct. 21, 1904. Serial. 1st part. No. 65841 A.

Some Old Engines in Cornwall. Illustrates and describes engines of ancient design. 1000 w. Engr, Lond—Oct. 14, 1904. No. 65697 A.

Variety in Steam Engines. Remarks on the great variety of engines for different uses with a review of the advantages and disadvantages of horizontal and vertical reciprocating steam engines and horizontal and vertical steam turbines. 2000 w. Mech Engr—Oct. 8, 1904. Serial. 1st part. No. 65586 A.

Engine Testing.

The Systematic and Accurate Testing

of Steam Engines. H. R. Sankey & C. H. Wingfield. Describing the very complete laboratory and methods of the Victoria Works at Rugby, and a review of the development of testing methods and appliances. 5000 w. Engineering Magazine—Nov., 1904. No. 65777 B.

Exhaust Steam.

The Utilization of Exhaust Steam, from Engines Acting Intermittently, by Means of Regenerative Steam Accumulators and of Low-Pressure Turbines on the Rateau System. Emile Demenge. An illustrated description of this system and the applications already in operation. 5600 w. Iron & Steel Inst—Oct., 1904. No. 65805 D.

Fuel Economy.

Fuel Economy in Central Generating Stations. John B. C. Kershaw. Reviews and discusses some recently published papers and articles on this subject, calling attention to points of importance. Ills. 4000 w. Elec Rev, N Y—Oct. 15, 1904. No. 65601.

Liquid Fuel.

Types of Oil Burners. Gives suggestions of the Naval Liquid Fuel Board. Ills. 1800 w. Ir Age—Sept. 29, 1904. No. 65364.

Piping.

Live Steam Piping: What Constitutes Good Design and What Should Be Avoided. Charles K. Stearns. Gives a few of the principles underlying good design, discussing details. 2000 w. St Ry Rev—Oct. 14, 1904 (Daily Ed.). No. 65597 C.

Power Plant.

The Power Plant of the Columbian Cordage Company. Illustrates and describes a steam power plant at Auburn, N. Y., interesting because of its remarkably rapid construction in view of the magnitude of the establishment. 2000 w. Eng Rec—Oct. 15, 1904. No. 65562.

Separators.

Devices for the Purification of Steam and Its Water of Condensation (Appareils pour l'Epuration de la Vapeur et de son Eau de Condensation). An exhaustive review of the various types of separators for removing water from live steam and oil from the exhaust. Serial. Part I. 4500 w. Revue de Mècanique—Sept., 1904. No. 65732 E + F.

Steam Turbines.

American Steam Turbines (Amerikanische Dampfturbinen). Clarence Feldmann. An account of the De Laval, Westinghouse-Parsons, and Curtis steam turbines, as studied by the writer during a visit to the United States. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Sept. 24, Oct. 1, 1904. No. 65705 each D.

Improvements in Fractional Supply Steam Turbines. Algidius Elling. Discusses the two types of turbines, those with parallel (or converging) nozzles, and those with diverging nozzles in the guide apparatus, showing the loss in working; and describes an innovation for diminishing the losses of efficiency. 2700 w. Prac Engr—Oct. 14, 1904. Serial. 1st part. No. 65682 A.

On the Steam Turbine in Germany. Dr. Alfred Gradenwitz. An illustrated short account of the status of the turbine question in Germany. The present article describes the Zoelly turbine. 1300 w. Prac Engr—Oct. 21, 1904. Serial. 1st part. No. 65848 A.

Steam Turbine Construction. O. Lasche. Illustrated description of experimental results obtained in the shops of the Union Elektricitäts-Gesellschaft. 1500 w. Power—Oct., 1904. No. 65418 C.

Steam Turbine Power Plants. J. R. Bibbins. Notes on their equipment and operation; discussing the economics of high vacua and superheat, condensers, cost, etc. Ills. 5500 w. St Ry Rev—Oct. 14, 1904. (Daily Ed.). No. 65596 C.

Steam Turbines. Richard H. Rice. Read before the convention of the Am. St. Ry. Assn. A discussion of types of the Curtis turbines, and the special problems that require solution. Gives a list of Curtis turbines of small sizes from 1½ to 300 kw., no gearing being used in the corresponding turbo-generators. 2300 w. Eng Rec—Oct. 15, 1904. No. 65563.

The DeLaval Steam Turbine Company. An illustrated description of their works and product, with sketch of Carl Gustaf P. De Laval, the Swedish inventor. 3500 w. Mach, N Y—Oct., 1904. No. 65427 C.

The Hamilton-Holzwarth Steam Turbine. Illustrated detailed description of a new steam turbine on exhibition at St. Louis. 4200 w. Ir Age—Sept. 29, 1904. No. 65362.

The Riedler-Stumpf Turbine and Its Applications. Abridged translation of a paper read by Dr. A. Riedler before the Oesterreichischen Ingenieur und Architekten Vereines. Illustrated description of his own turbine. 2500 w. Power—Oct., 1904. No. 65419 C.

Thermodynamic Diagrams for Steam-Turbine Computations (Thermodynamische Rechentafel für Dampfturbinen). Dr. R. Proell. Discussing straight-line diagrams for abridging the labor of computations, both for saturated and superheated steam. 2000 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1904. No. 65703 D.

See Also Electrical Engineering, Generating Stations.

See Also Marine Engineering.

Tube Cleaners.

Concerning Tube Cleaners. An illustrated article discussing the damage done by power cleaners for boiler tubes. 2800 w. Locomotive—Oct., 1904. No. 65593.

Valve Gears.

Adjustment of Corliss Valve Gears. Ralph D. Van Valkenburgh. An illustrated article considering the essential conditions for valve gears and how to set them for best performance. 3000 w. Ice & Refrig—Oct., 1904. Serial. 1st part. No. 65401 C.

MISCELLANY.

Aeronautics.

A Device for the Application of Intermittent Efforts to the Propulsion of Masses in Elastic Media (Konstruktion zur Ermöglichung der Intermittierenden Kraftausnützung bei Fortbewegung von Massen in Elastischen Mitteln). Viktor Hänisch. Describing a mechanical movement for reproducing wing motion in flight. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Sept. 16, 1904. No. 65725 D.

Mechanical Flight. J. Emery Harriman, Jr. Considers, mainly, flying machines heavier than the air displaced by them, referring to the machines of Lilienthal, Chanute, the Wright brothers, Harriman, and others. Ills. 4000 w. Jour Assn of Engng Socs—Aug., 1904. No. 65515 C.

The 1904 Campaign of the Lebaudy Balloon (La Campagne de 1904 du Ballon Lebaudy). Col. G. Espitallier. With views of the latest Lebaudy dirigible balloon, and an account of the experimental trips of the year. 2000 w. Génie Civil—Oct. 1, 1904. No. 65721 D.

Guns.

Machine Guns Up to Date. Lieut.-Colonel E. Rogers. Gives an account of the use of these guns in various battles. General discussion follows. 10000 w. Jour Roy United Service Inst—Sept., 1904. No. 65358 E.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Virginia Anthracite Coal Field. L. L. Randolph. A descriptive historical account of this field, which was first discovered fifty years ago. Map and sections. 2000 w. Eng News—Oct. 20, 1904. No. 65636.

Briquets.

The Fuel Briquetting Industry. John Fulton. Considers the materials of which briquets are made, binders, fuel value, shapes of briquets, and processes and machinery used. Ills. 4600 w. Mines & Min —Oct., 1904. Serial. 1st part. No. 65394 C.

British Columbia.

Coal in British Columbia. W. A. Harkins. Outlines the results accomplished at Coleman in less than a year, in these bituminous coal lands. 1700 w. Min & Sci Pr—Oct. 15, 1904. No. 65676.

Graham Island Coal. William Blakemore. This island is the most northerly of the Queen Charlotte group, on the northwest coast of British Columbia. Gives information of these deposits and their value. 1200 w. Eng & Min Jour—Oct. 20, 1904. No. 65649.

Coal Handling.

The Coal Handling Plant at the Gerhard Mine at Louisenthal on the Saar (Die Einrichtungen zur Verladung von Kohlen auf der Grube Gerhard bei Louisenthal a. d. Saar). H. Althans. With plans of the buildings and tracks, and illustrations of the conveyors, cranes and buckets for delivering the coal into barges by the wharf. 3000 w. 5 plates. Glückauf—Sept. 17, 1904. No. 65760 D.

Coal Testing.

Coal-Testing Plant of the U. S. Geological Survey at St. Louis. Kurt Toensfeldt. An illustrated description of this plant and the methods of testing. 1800 w. Engr,. U S A—Oct. 15, 1904. No 65607 C.

Coal Washing.

A Modern Method of Coal Washing. C. A. Meissner. Abstract from the *Journal* of the Min. Soc. of Nova Scotia. Describes the washing at the plant of the Dominion Iron and Steel Company. 1200 w. Eng & Min Jour—Oct. 13, 1904. No. 65552.

Coal Working.

On the Methods of Working Coal in Saxony and Austria. Illustrates and describes the methods used in these collieries, and describes the working of lignite in northwest Bohemia. 2500 w. Ir & Coal Trds Rev—Oct. 7, 1904. No. 65581 A.

Coke.

Notes on the Manufacture of Coke. John Bell. Abstract of a paper read before the British Soc. of Min. Students. Deals only with ovens of the beehive type. Ills. 2500 w. Ir & Coal Trd Rev—Oct. 7, 1904. No. 65580 A.

Preparation of Alabama Coal for Coke Making. L. O. Gabany. Abstract of a paper read before the Engng Assn. of the South. Describes the coal and the treatment needed. 1300 w. Eng & Min Jour—Oct. 27, 1904. No. 65829.

Colliery.

The Henry Colliery of the Davis Coal and Coke Company. J. F. Healy. An illustrated description of the plant and the mechanical equipment. 2700 w. Mines & Min—Oct., 1904. No. 65398 C.

Gas Coal.

The Determination of the Value of Gas Coals (Die Wertbestimmung der Gaskohlen). Dr. Bertelsmann. A comparison of various English and German coals with regards to their adaptability for the production of illuminating gas. 2000 w. Glückauf—Sept. 24, 1904. No. 65762 D.

New Mexico.

The Hagan Coal Field. Charles R. Keyes. Brief illustrated description of a newly opened coal-field in New Mexico, showing some features of the cretaceous coals of the Southwest. 800 w. Eng & Min Jour—Oct. 27, 1904. No. 65831.

New Mine.

A Monongahela River Mine. Brief description of the opening of a new coal mine. 1200 w. Eng & Min Jour—Oct. 6, 1904. No. 65487.

COPPER.

Arizona.

The Warren District, Arizona. An illustrated article describing recent developments which have made Bisbee one of the largest copper mining camps in the United States, and giving information in regard to the deposits. 2500 w. Eng & Min Jour—Oct. 6, 1904. No. 65488.

Chemistry.

The Chemistry and Metallurgy of Copper. Charles D. Palmer. The first of a series of papers. The present number considers the meaning of the word metal, and its two lines of properties, the physical and the chemical. 4000 w. Eng & Min Jour—Oct. 20, 1904. Serial. 1st part. No. 65647.

Lake Superior.

Copper Mines of Lake Superior. T. A. Rickard. The first of a series of articles giving an illustrated detailed description of the copper mining region of the Keweenaw peninsula in Northern Michigan. 2000 w. Eng & Min Jour—Oct. 13, 1904. No. 65548.

Refining.

Some Notes on the Electrolytic Refining of Copper at Anaconda, Montana. E. C. Sickles. Description and general information of one of the most economical and complete electrolytic plants. Ills. 1400 w. Sib Jour of Engng—Oct., 1904. No. 65670 C.

Smelting.

Ore-Roasting at the Tyree Copper Company's Smelter on Vancouver Island. E. Jacobs. Describes the manner of dealing with the bulk of the ore before it reaches the furnace, particularly the arrangement, appointments and operating methods of the ore-roasting yard. Ills. 1800 w. B C Min Rec—Oct., 1904. No. 65546 B.

United States.

Occurrence and Distribution of Copper in the United States. Walter Harvey Weed. An illustrated article giving information in regard to the location, value, and production of the deposits. Maps. 2800 w. Min Mag—Sept., 1904. No. 65353 C.

Vancouver.

Copper Deposits of Mt. Sicker, Vancouver. Robert Musgrave. Describes the formation and deposits. The ore is chalcopyrite, associated with pyrite, blende and galena, in a gangue consisting mainly of barite, with some quartz and calcite. 1700 w. Eng & Min Jour—Oct. 27, 1904. No. 65832.

GOLD AND SILVER.

Amalgamation.

Milling Practice at the Hidden Fortune Plant, with Special Reference to Amalgamating in Cyanide Solution. Jesse Simmons. Describes this wet crushing cyanide mill, especially the process of amalgamating in a solution of cyanide of potassium. 2000 w. Min Rept—Oct. 20, 1904. No. 65673.

Assaying.

The Assay Weight and Its Relation to the Balance of Precision. A. Whitby. On the difficulty of obtaining weights of sufficient accuracy for the requirements of the more sensitive balance now used. General discussion. 5500 w. Jour Chem Met & Min Soc of S Africa—Aug., 1904. No. 65588 E.

Brazil.

Gold Mines of Minas, Brazil. Martin Schwerin. Points of interest in regard to the gold mines in the State of Minas Geraes. 2000 w. Eng & Min Jour—Oct. 6, 1904.. No. 65489.

Chlorination.

Chlorination in Colorado. William E. Greenawalt. Describes the methods employed, the machinery used and the results. Ills. 3000 w. Eng & Min Jour—Oct. 27, 1904. No. 65830.

The Portland Mill. F. A. Thomson and S. L. Goodale. An illustrated description of the chlorination plant of the Portland Gold Mining Co., at Colorado Springs, Colo. 4600 w. Mines & Min—Oct., 1904. No. 65393 C.

Crushing in Cyanide Solution as Carried on in the Black Hills, S. D. C. H. Fulton. A description of the process. 1500 w. Min & Sci Pr—Sept. 24, 1904. Serial. 1st part. No. 65420.

Deposition.

Gold Deposition by Drainage. William Bradford. An illustrated article giving briefly the writer's views on gold deposit. 500 w. Eng & Min Jour—Oct. 6, 1904. No. 65491.

Milling.

Notes on Mill Construction, Milling and Amalgamation. I. Roskelly. Reply to the discussion of the writer's paper on this subject. 4000 w. Jour Chem Met & Min Soc of S Africa—Aug., 1904. No. 65590 E.

Nevada.

Observations on Tonopah and Goldfield. S. C. Wiel. An illustrated article describing the free gold deposits of Goldfield and the silver deposits of Tonopah, and the methods of mining. 1700 w. Min & Sci Pr—Oct. 8, 1904. No. 65602.

New Goch.

Visit to the New Goch Mines, Ltd. Explanatory remarks by H. S. Denny, on the occasion of a visit to this South African mine to inspect the new tube-mill installation and the treatment of vanner concentrates. 3000 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1904. No. 65591 E.

Nova Scotia.

Stamp Milling Practice in Nova Scotia. Mr. R. O'Shaughnessy. Describes the practice in wet crushing stamp mills. 1300 w. Min & Sci Pr—Oct. 15, 1904. Serial. 1st part. No. 65677.

Ore Treatment.

Ore Treatment at the Ivanhoe Mine, Kalgoorlie. H. J. Brooke. The plant embraces all the successful methods at present in vogue at Kalgoorlie. Descriptive. 1300 w. Eng & Min Jour—Oct. 20, 1904. No. 65651.

Pulp Distribution.

Pulp Distributor for Stamp Batteries. J. L. Buskett. Description and drawings of a pulp distributor which allows of the continuous dropping of the stamps while dressing the plates. 1000 w. Min Rept—Oct. 20, 1904. No. 65674.

Slimes.

Improvements in Slimes Treatment. M. Torrente. Describes a method which refers to the settlement and separation of the slimes from their solutions, and states other advantages derived. 2200 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1904. No. 65589 E.

Supply.

The Future Supply of Gold. From the London *Economist.* Considers that the study of new mines is not keeping pace with the exhaustion of those now being worked. Gives a brief survey of the world's mines. 2400 w. Ir Age—Oct. 6, 1904. No. 65469.

Victoria.

Deep Alluvial Mining in Victoria. F. Danvers Power. Describes the deep leads and the systems of mining. Ills. 2000 w. Eng & Min Jour—Sept. 29, 1904. No. 65403.

IRON AND STEEL.

Analysis.

Comparisons of Methods for the Determination of Carbon and Phosphorus in Steel. Baron H. Jüptner von Jonstorff, Andrew A. Blair, Gunnar Diltner, and J. E. Stead. Remarks by each member of this committee on the methods, with a summary of results. Ills. 15400 w. Iron & Steel Inst—Oct., 1904. No. 65807 D.

Blast Furnaces.

Modern Blast Furnace Construction. I. G. Bayley. A list of requirements from the drawing-office point of view. 6000 w. Ir Age—Sept. 29, 1904. No. 65365.

Canada.

Iron and Steel for Western Canada. William Blakemore. Discussing the possibility of establishing a steel-making industry in British Columbia which would serve the West with cheaper iron and steel and yet realize a profit. 1800 w. Eng & Min Jour—Oct. 13, 1904. No. 65549.

Carbon.

The Determination of Carbon. James A. Aupperle. With special reference to the stability of carbon compounds in steel. 2200 w. Ir Age—Oct. 6, 1904. No. 65470.

Constituents.

The Influence of Carbon, Silicon, Manganese, Sulphur, and Phosphorus Upon the Formation of Temper Carbon in Iron (Der Einfluss von Kohlenstoff, Silizium, Mangan, Schwefel, und Phosphor auf die Bildung der Temperkohle in Eisen). F. Wirst and P. Schlosser. Data and results of tests showing the influence of the various constituents. 2000 w. Stahl u Eisen—Oct. 1, 1904. No. 65771 D.

Dry-Air Blast.

The Application of Dry-Air Blast to the Manufacture of Iron. James Gayley. An account of the application of the dry-air blast at the Isabella Furnaces of the Carnegie Steel Co., at Etna, Pa., and the economies resulting. Ills. 5400 w. Iron & Steel Inst—Oct., 1904. No. 65801 D.

Furnace Lifts.

Inclined Cable Lifts for Blast Furnaces (Gichtseilbahnen). Rudolph Brennecke. Illustrating and describing a variety of inclined converging devices for delivering the charge to blast furnaces. 2500 w. 2 plates. Stahl u Eisen—Oct. 1, 1904. No. 65770 D.

Lake Superior.

Investigations on the Lake Superior Iron Ore Deposits. U. S. Grant. Gives points of interest concerning the results of the survey of these iron districts. Ills. 3200 w. Min Mag—Sept., 1904. No. 65352 C.

Through the Lake Superior Iron and Copper Mines with the American Institute of Mining Engineers. A brief account of the trip, the sail through the lakes, the Duluth meetings, etc., in the present number. 2200 w. Eng News—Sept. 29, 1904. Serial. 1st part. No. 65371.

New Mexico.

Iron Deposits of the Chupadera Mesa. Charles R. Keyes. Describes the geological conditions under which these deposits were formed, and the conditions which have exposed them to view. 900 w. Eng & Min Jour—Oct. 20, 1904. No. 65650.

Open-Hearth.

Acid Open-Hearth Manipulation. Andrew McWilliam and William H. Hatfield. Investigations made by the writers, showing the chemical composition of the slag, particularly with regard to its acidity, is the factor which determines whether the percentage of silicon in the molten steel shall increase or decrease. 1700 w. Iron & Steel Inst—Oct., 1904. No. 65806 D.

The Influence of Carbon, Phosphorus, Manganese and Sulphur on the Tensile Strength of Open-Hearth Steel. H. H. Campbell. Gives an account of investigations made at the works of the Pennsylvania Steel Co., Steelton, Pa. 10000 w. Iron & Steel Inst—Oct., 1904. No. 65804 D.

Pig-Iron.

Pig-Iron in Its Commercial Aspects. F. M. Thomas. Abstract of a lecture delivered before the Birmingham (Eng.) Metallurgical Society. Considers methods of casting, commercial uses, grading, relative values, selection, testing, etc. 6000 w. Ir & Coal Trds Rev—Sept. 23, 1904. No. 65453 A.

Rolling Methods.

The Rolling of Sections in Iron and Steel. Adolph S. While. Describes methods which have given entirely satisfactory results, giving drawings of the rolls and templates used. 2200 w. Ir Age—Oct. 13, 1904. Serial. 1st part. No. 65538.

Smelting.

A West African Smelting House. C. V. Bellamy. Illustrated account of methods now in use in the Colony of Lagos, West Africa, which are believed to be the same as those practiced by the earliest workers in this metal. 6000 w. Iron & Steel Inst—Oct., 1904. No. 65802 D.

Steels.

See Mechanical Engineering, Materials.

Sulphur.

A Radically New Method for the Determination of Sulphur in Irons and Steels. H. B. Pulsifer. Describes a new method devised by the author, much more rapid than the two methods at present recognized. 1400 w. Ir & St Mag—Oct., 1904. No. 65614 D.

Tennessee.

The Iron Ores of Shady Valley, Tennessee. F. Lynwood Garrison. Describes the creation, geology and deposits; their composition, value, etc. 3000 w. Eng & Min Jour—Oct. 13, 1904. No. 65551.

Wisconsin.

The Baraboo Iron Ore. N. H. Winchell. Discusses these deposits in Wisconsin, considering their structure, formation, etc., as discussed by Samuel Weidman in a recent publication. 4500 w. Am Geol—Oct., 1904. No. 65659 C.

MINING.

Alaska.

The Copper River Country, Alaska. W. R. Abercrombie. An interesting account of exploration work in this region. Ills. 7500 w. Jour Fr Inst—Oct., 1904. Serial. 1st part. No. 65437 D.

Blasting.

Large Blasting Operations in Slate Quarries. Illustrates and describes some unusually large blasts carried out in North Wales. 2200 w. Ir & Coal Trds Rev—Sept. 30, 1904. No. 65531 A.

Equipment.

English and German Designs for Electrical Mining Equipment. Frank C. Perkins. Gives illustrations of the power house at the Sneyd mine in Staffordshire, England, and considers details of German and English designs, the generating and lighting stations, distribution, electric haulage and winding machines, underground pumping plants, etc. 1600 w. Min Rept—Oct. 20, 1904. Serial. 1st part. No. 65672.

Italy.

A Survey of the Mines and Mineral Industries of Italy. Enrico Bignami. Describing especially the sulphur deposits of Sicily. 3000 w. Engineering Magazine—Nov., 1904. No. 65775 B.

Mining Débris.

A Great Engineering Problem. W. A. Lawson. An account of the effort to be made to arrest the flow of mining débris in the Yuba River, and prevent its descent into the Feather, and so on to the Sacramento, to the detriment of navigation. 2500 w. Eng & Min Jour—Oct. 13, 1904. No. 65550.

Mining Law.

Mining Engineering and Mining Law. James D. Hague. Read at St. Louis, before the Int. Cong. of Arts and Sciences. Shows the important relations of the United States mining law to the vocation of the American mining engineer. 4500 w. Eng & Min Jour—Oct. 20, 1904. No. 65648.

Mining Machinery.

The Power Required for Mining Machinery (Kraftbedarf von Bergwerksmaschinen). J. L. Huber. Results of electric power measurements showing the amount and distribution of power, from observations in coal and salt mines. 1200 w. Glückauf—Oct. 1, 1904. No. 65763 D.

Ore Handling.

Ore-Handling Plant at the Clairton Works of the Crucible Steel Company. Charles H. Wright. An illustrated article describing how ore, limestone, and coke are conveyed from railroad cars to the furnace. 5500 w. Jour Assn of Engng Soc's—Aug., 1904. No. 65514 C.

Ore Mills.

Ore Mills at the Louisiana Purchase Exposition. Brief, illustrated descriptions of the working mills and models exhibited by California, Utah, and South Dakota. 2200 w. Mines and Min—Oct., 1904. No. 65395 C.

Quarrying.

The Cost of Quarrying Rubble and Dimension Stone for the Buffalo (N. Y.) Stone Breakwater. Emile Low. Briefly describes the method of quarrying, and gives figures of cost for 1903, from May to September, inclusive. Ills. 600 w. Eng News—Oct. 20, 1904. No. 65634.

Respiration.

Improved Respirators for Mining Service (Nouveaux Appareils Respiratoires en Usage dans les Mines). H. Schmerber. Describing the recent German devices for using oxygen in exploring and rescue work in mines. 3000 w. Génie Civil—Oct. 1, 1904. No. 65720 D.

Rock Drills.

The Action of Valve Gears in Pneumatic Rock Drills (Die Wirkungsweise der Steuerungen an Druckluft-Gesteinsbohrmaschinen). Carl Weidmann. A review of the different systems of operating the valves, with diagrams showing their action. 4500 w. Glückauf—Sept. 24, 1904. No. 65761 D.

Rock Movements.

Some Recent Rock Movements in the Laurentian and Huronian Areas. S. Dillon Mills. Read before the Can. Min. Inst. A statement of conclusions from a study of these regions. 3000 w. Can Min Rev—Sept. 30, 1904. No. 65402 B.

Safety Catch.

The Hoppe Safety Brake (Die Neue Hoppesche Fallbremse). W. Gentsch. Describing an improved safety catch for the cages of mine hoists. 1000 w. Zeitschr d Ver Deutscher Ing—Sept. 24, 1904. No. 65707 D.

The Karlik-Witte Safety Stop Apparatus for Hoisting Engines. Alfred Gradenwitz. Illustrated detailed description of the apparatus and its working. 2000 w. Min Rept—Oct. 13, 1904. No. 65600.

Sketching.

Sketching Mineral Veins. Prof. Arthur Lakes. An illustrated article on the methods of representing different rocks and minerals on sketches. 1200 w. Mines & Min—Oct., 1904. No. 65397 C.

Surveying.

Mine Surveying and Mapping. Charles E. Rowe. Describes a system which will be found useful in the surveying of flat or moderately pitched seams of coal, and parts of it may be applied to any underground surveying. 3000 w. Min Rept—Sept. 29, 1904. Serial. 1st part. No. 65390.

Tubbing.

Corrugated Tubbings (Gewellte Tubbings). Prof. Heise. A discussion of the use of corrugated metal for securing increased strength and lightness in lining shafts. 2500 w. Glückauf—Oct. 8, 1904. No. 65764 D.

Winding.

Computations for Electrically Driven Winding Machinery (Berechnung Elektrisch Betriebener Fördermaschinen). H. Koch & H. Schmiede. Developing formulas and diagrams showing the conditions involved in mine hoisting work, together with methods of regulating and controlling electric motors for winding service. 7000 w. Elektrotech Zeitschr—Sept. 22, 1904. No. 65736 B.

Winding Engines.

The Winding Engines of the Arnim

Alexander Mine and the Prince Hohenlo Max Mine (Die Fördermaschinen auf dem v. Arnimschen Alexanderschacht und der Fürstlich Hohenloheschen Maxgrube). W. Gentsch. Illustrating an electrically driven mine hoist and a double steam winding engine. 1500 w. Zeitschr d Ver Deutscher Ing—Oct. 1, 1904. No. 65712 D.

MISCELLANY.

Bitumen.

The Origin of Bitumen. W. C. Morgan. Reviews the theories that have been advanced, and claims that it has been proven that bitumen is derived from animal sources, though it does not deny that there may also be other sources. 1300 w. Cal Jour of Tech—Sept., 1904. No. 65512 C.

Exposition.

Mining and Metallurgy at the St. Louis Exposition. H. Bauerman. A review of exhibits of interest to the iron and steel industry. 14000 w. Iron & Steel Inst—Oct., 1904. No. 65808 D.

Mercury.

Condition of the Quicksilver Industry in Brewster County, Texas. William B. Phillips. Gives information of the work of the various companies, with the opinion that the industry is in a healthy condition in spite of the closing down of two plants. 2000 w. Eng & Min Jour—Oct. 6, 1904. No. 65490.

The Determination of Mercury in Ores. W. W. Whitton. Reviews the methods for the determination of ores, especially the distillation-amalgamation assay, and gives a modification of this method. It is simple, quite accurate and requires no special apparatus. Ills. 2300 w. Cal Jour of Tech—Sept., 1904. No. 65511 C.

Minerals.

The Non-Metallic Mineral Products of the United States. Edwin C. Eckel. Gives facts relative to the geographic distribution and commercial development of the various non-metallic mineral products. Ills. and maps. 2500 w. Min Mag—Sept., 1904. No. 65351 C.

Salt.

Kansas Salt Industry. W. R. Crane. Illustrates and describes the methods employed in obtaining brines, and the arrangement of the evaporating and manufacturing apparatus. 3500 w. Mines & Min—Oct., 1904. No. 65396 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Electrification.

The Application of Electricity to Steam Railroads. Bion J. Arnold. Extracts from the President's address before the International Electrical Congress, St. Louis. 2500 w. R R Gaz—Vol. XXXVII., No. 17. No. 65492.

The Electrification of Steam Railways. F. F. Bennett. An endeavor to show that electrification of railways would be remunerative in thinly populated districts, as well as thickly populated, if the various companies would combine. 7800 w. Public Works—Oct. 15, 1904. No. 65623 D.

The Substitution of Electricity for Steam as a Motive Power. Abstract of a paper by Alexander Siemens, before the Int. Engng. Cong. A statement of conclusions reached thus far from the experimental work on the line between Marienfelde and Zossen. 2000 w. R R Gaz—Vol. XXXVII., No. 18. No. 65558.

Labor.

On the Question of Duration and Regulation of work. Pl. Weissenbach. (Subject XV for discussion at the seventh session of the Railway Congress). Report No. 1 for Switzerland. 11300 w. Bul Int Ry Cong—Sept., 1904. No. 65617 E.

On the Question of the Duration and Regulation of Work. Mr. Philippe. (Subject XV for discussion at the seventh session of the Railway Congress). For all countries, except America and Switzerland. 31000 w. Bul Int Ry Cong—Sept., 1904. No. 65618 E.

Operation.

Economical Train Operation. G. R. Henderson. Endeavors to make clear how the most efficient rating may be practically studied both as regards cost of operation and amount of business handled. 3000 w. Am Engr & R R Jour—Oct., 1904. Serial. 1st part. No. 65411 C.

Train Service.

British Autumn Train Services. Charles Rous-Marten. A review of the general scheme of train services for the autumn on the railways of Britain. 2000 w. Engr, Lond—Oct. 14, 1904. No. 65694 A.

MOTIVE POWER AND EQUIPMENT.

Cars.

American Freight Cars of Large Capacity (Amerikanische Güterwagen mit Grosser Ladefahigkeit). M. A. Nüscheler. A discussion of the economy attainable by the use of cars of large capacity; with examples from American practice. 2500 w.

Glasers Annalen—Oct. 1, 1904. No. 65752 D.

Sixty-Foot-Horse Car, Central R. R. of New Jersey. Illustrated description of cars designed for the transportation of blooded stock. 600 w. Ry & Engng Rev—Oct. 8, 1904. No. 65507.

Coupler.

The Automatic Air and Steam Coupler. Illustrated description of the undersized automatic air and steam coupler as manufactured by the Westinghouse Air Brake Co. 400 w. Loc Engng—Oct., 1904. No. 65417 C.

Grates.

The Relative Merits of Large Grates and Heating Surfaces and Their Proportions. Extracts from the report of the Committee on Coal Consumption in Locomotives, read at the last convention of the Am. Ry. Mas. Mechs. Assn. Also discussion. 5700 w. Pro W Ry Club—Sept. 20, 1904. No. 65654 C.

Locomotives.

American Locomotives. Abstract of a paper by William Forsyth, presented before the Int. Engng. Cong. Discusses modern designs, the changes made in four-cylinder balanced compounds, boilers, etc., and the operation of locomotives as affected by the fireman, valves, etc. 6000 w. R R Gaz—Vol. XXXVII., No. 18. No. 65555.

Express Passenger Engine, London and North-Western Railway. Illustrations, with dimensions of a new type of express engine for working heavy high-speed passenger traffic. 400 w. Engr, Lond—Oct. 14, 1904. No. 65695 A.

Express Passenger Locomotive for the London and South-Western Railway. Illustrated description, with dimensions. 900 w. Engng—Sept. 23, 1904. No. 65450 A.

Negative Work of Back Pressure and Compression. Ira C. Hubbell. Claims that compression is negative, and that by delaying the closure of the exhaust part the volume in compression is decreased and also the negative work, and consequently the work to be obtained from a given quantity of steam is increased. Discussion follows. 11000 w. Pro W Ry Club—Sept. 20, 1904. No. 65653 C.

New Compound Locomotives in Bavaria. Charles R. King. An illustrated description of locomotives largely representative of the most approved and latest European practice, with discussion of details. 2500 w. R R Gaz—Vol. XXXVII., No. 19. No. 65657.

New Locomotives for the Southern Pacific. Brief illustrated description of four recent locomotives, three of which use oil as fuel. 500 w. R R Gaz—Vol. XXXVII., No. 16. No. 65368.

Recent Locomotives for Local Traffic (Neuere Vorortzug-Lokomotiven). E. Metzeltin. Illustrating and describing a number of small engines for local service, from recent German designs. Serial. Part I. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Oct. 1, 1904. No. 65709 D.

Six-Coupled Locomotive for the Pekin Syndicate Railways. Illustration and principal dimensions. 500 w. Engng—Sept. 30, 1904. No. 65525 A.

Ten Wheel Passenger Locomotive, with Wide Firebox Boiler.—C. B. & Q. Lines West. Dimensions and description. 1000 w. Ry Mas Mech—Oct., 1904. No. 65599.

The Cole Balanced Compound Locomotive at the St. Louis Exhibition. H. W. Hanbury. Perspective view, general drawing and description. 2000 w. Engng—Oct. 21, 1904. No. 65837 A.

The Cross-Compound Locomotive. W. L. Kinsell. Gives a report of tests made on the Chicago, Great Western Railway, which emphasize the necessity for a careful study of the power distribution of these engines. 1200 w. Am Engr & R R Jour—Oct., 1904. No. 65413 C.

The Locomotive Exhibits at the St. Louis Exhibition. Illustrations and leading dimensions of the engines, with particulars, also editorial. 4800 w. Engng News Oct. 6, 1904. No. 65476.

Locomotive Tests.

Tests of Locomotives on the French State Railway. Abstract of articles by Joseph Nadal, appearing in the *Revue Generale des Chemins de Fer.* An account of tests made of five different types of locomotives, for the purpose of examining the efficiency of operation of the steam in the cylinders, and other matters of interest. The results are discussed. 1600 w. R R Gaz—Oct. 28, 1904. Serial. 1st part. No. 65833.

Motor Cars.

Motor Cars for Light Passenger Traffic on Steam Railways. Gives information of lines in England and the United States, and a report on motor cars on European railways. 4000 w. Eng News—Oct. 13, 1904. No. 65541.

Rolling Stock.

Locomotives and Other Rolling Stock. Abstract of a paper by Edouard Savage, presented to the International Engineering Congress, St. Louis. Considers modern locomotives and their performance on French railroads, with brief reference to passenger carriages and goods wagons. 3000 w. R R Gaz—Vol. XXXVII., No. 17. No. 65493.

Rolling Stock on the Leek and Manifold Light Railway. Illustrated description of cars for a 2 ft. 6 in. gauge. 800 w. Engr, Lond—Oct. 21, 1904. No. 65842 A.

Trucks.

Flange Wear and Side Bearing Trucks. Gustav Lindenthal. Shows the forces that produce flange wear and the way to reduce them, with a view to economy. Full paper and discussion. Ills. 9700 w. N Y R R Club—Sept. 16, 1904. No. 65594.

NEW PROJECTS.

Australia.

Western Union Railway of Australia. Information concerning Australian railways, and the proposed construction of a line connecting the systems of Western and Southern Australia. 1400 w. Engr, Lond—Oct. 14, 1904. No. 65699 A.

Ecuador.

Construction Difficulties on the Guayaquil & Quito Railway. An illustrated article describing the building of this railroad in the tropics. 1500 w. Eng Rec—Oct. 22, 1904. No. 65666.

Italy.

The Proposition for a New Apennine Railway from Genoa to Tortona (Die Erstellung einer Neuer Apenninbahn von Genua nach Tortona). E. Bavier. With profile and plan of the route, which includes a tunnel 20 kilometres in length at Rigoroso. Two articles. 4000 w. Schweiz Bauzeitung—Sept. 17, 24, 1904. No. 65765 each B.

PERMANENT WAY AND BUILDINGS.

China.

The Actual Building of a Chinese Railway. Justin Burns. A fully illustrated account of the operative conditions of railway construction on the Canton-Hankow Railway. 4000 w. Engineering Magazine —Nov., 1904. No. 65773 B.

Construction.

The St. Louis, Kansas City & Colorado. J. L. Campbell. Illustrated description of a new line constructed on an exceptionally permanent basis for a new road. 4500 w. R R Gaz—Vol. XXXVII., No. 19. No. 65656.

Crossties.

On the Question of Wooden Sleepers or Cross Ties. Mr. Hausser. Report for all countries except America. Selection of species of timber used and processes of preservation. (Subject 1-A, for discussion at the seventh session of the Railway Congress). 7000 w. Bul Int Ry Cong—Sept., 1904. No. 65616 E.

Ditching Costs.

Cost of Ditching Cuts and Widening Embankments. Extracts from a committee report to the St. Louis meeting of the Roadmasters and Maintenance-of-Way Assn. 3500 w. R R Gaz—Vol. XXXVII., No. 19. No. 65658.

Engine Houses.

Square Engine House—Terminal Railroad Association of St. Louis. Illustrated description of the houses serving the passenger engines during the World's Fair. 2200 w. Ry Mas Mech—Oct., 1904. No. 65598.

Rails.

Some Notes on the Creeping of Rails. Discussion of paper by Samuel Tobias Wagner. 7000 w. Pro Am Soc of Civ Engrs—Oct., 1904. No. 65821 E.

Signals.

Controlled Manual Block Signals—Illinois Central. Illustrates and describes a manually controlled block system installed on certain single-track lines carrying heavy traffic. 1200 w. Ry Age—Oct. 7, 1904. No. 65501.

On the Question of the Automatic Block System. (Subject X for discussion at the seventh session of the Railway Congress.) C. H. Platt. Report for America. Ills. 11000 w. Bul Int Ry Cong—Sept., 1904. No. 65619 E.

Lightning and Automatic Block Signals. H. S. Balliet. A discussion of the kinds of fractures due to lightning, the cause and the efforts to correct these troubles. Ills. 2200 w. R R Gaz—Vol. XXXVII., No. 16. No. 65366.

Terminals.

Railroad Terminals. Elmer L. Corthell. Read before the Int. Engng Cong., St. Louis. Classifies the types of large stations, discussing them in detail and giving interesting tables. 6000 w. Ry & Engng Rev—Oct. 8, 1904. No. 65508.

Tracks.

Rearrangements of Tracks and Station Facilities at the Union Station, St. Louis, Mo. An illustrated description of the arrangements made for handling the great increase in traffic during the World's Fair. 5200 w. Eng News—Sept. 29, 1904. No. 65372.

Track Depression of the Chicago & Northwestern Railway at Milwaukee. An illustrated description of work presenting features of great interest, the object being the separation of the traffic of the railway from the city streets. 2000 w. Ry Age—Oct. 14, 1904. No. 65560.

Trestles.

The Care of Railroad Trestles While Being Filled. From a report presented at the convention of the Assn. of Ry. Supts. of Bridges and Buildings on the best methods of caring for trestles while being filled. 2400 w. Eng Rec—Oct. 22, 1904. No. 65665.

TRAFFIC.

Parcels.

Small Parcels Traffic in England. Describes the methods employed by the London & Northwestern Railway as typical of general practice. 3500 w. Ry Age—Oct. 2, 1904. No. 65661.

Per Diem.

Comments on the Per Diem Rules. Arthur Hale. Comments on the rules in their order. Also editorial. 4500 w. Ry Gaz—Vol. XXXVII., No. 18. Serial. 1st part. No. 65553.

Pooling.

On the Question of Pooling Locomotives (Subject VI. for Discussion at the Seventh Session of the Railway Congress). Mr. Bell. Report (No. 1) for all countries, except United States, Belgium, England and Colonies, Holland, Denmark, Russia, Sweden and Norway. 4000 w. Bul Int Ry Cong—Sept., 1904. No. 65615 E.

United States.

Traffic on Improved Waterways and Railroads in the United States. Edward P. North. Extracts from a paper read before the Int. Engng. Cong. Gives much information of the development of transportation facilities in the United States, and the causes that have made possible the low rates as compared with other countries. 4000 w. R R Gaz—Vol. XXXVII., No. 18. No. 65556.

MISCELLANY.

India.

Railways in British India. Information of interest relating to the railways of India. 2500 w. Ry Age—Oct. 7, 1904. Serial. 1st part. No. 65500.

Specifications.

Standard Specifications for Mechanical Interlocking Material and Construction Work. Extracts from a set of specifications submitted at the annual convention of the Railway Signal Assn., at St. Louis. 2000 w. Eng News—Oct. 20, 1904. No. 65638.

STREET AND ELECTRIC RAILWAYS

Basle.

Electric Power Plant—Basle Tramways. A general illustrated description of the extension of the Basle system. 1400 w. Trac & Trans—Oct., 1904. No. 65536 E.

Boosters.

"Negative" Boosters. J. Stanley Richmond. Part first contains a theoretical and experimental discussion of the return current in electric railways, with diagrams. 3000 w. Elec Rev, N. Y.—Oct. 8 & 15, 1904. Serial. 2 parts. No. 65504.

Brooklyn.

Rapid Transit Railway Construction in Brooklyn. The present article gives an illustrated description of work on Section 3, Division 5, which extends from Flatbush and Atlantic Avenues to Clinton and Joralemon Sts. 3300 w. Eng Rec—Oct. 22, 1904. Serial. 1st part. No. 65669.

Burma.

Electric Tramway in Mandalay. Illustrated detailed description of the first electric railway in Burma, which has been in operation two or three months. 1500 w. Elec Engr, Lond—Sept. 30, 1904. No. 65520 A.

Electric Tramways in Mandalay. Illustrates and describes recently opened tramway route 7 miles in length, double-track throughout. 1500 w. Tram & Ry Wld—Oct. 13, 1904. No. 65827 B.

Cable Incline.

Inclined Cable Road Up to the Hohensyburg, Westfalen Province, Germany. Franz Koester. Illustrated detailed description. 1500 w. Elec Rev, N. Y.—Oct. 8, 1904. No. 65503.

The Funicular Railway of Bourboule (Le Funiculaire de la Bourboule). A. Dumas. Describing a cable incline railway from the village of Bourboule, Auvergne, to a plateau 300 metres above, with an account of the hydroelectric station. 2000 w. 1 plate. Génie Civil—Sept. 17, 1904. No. 65714 D.

Cars.

Cars: Their Equipment and Maintenance. John Aldworth. Read at the Liverpool Congress of the Munic. Tram. Assn. of Gt. Britain. Considers the more important features, giving observations based on methods in operation on the Nottingham system. 3500 w. Elec Engr, Lond—Sept. 30, 1904. No. 65521 A.

General Design and Finish of the Modern Interurban Car. Edward C. Boynton. An illustrated description of recent improvements introduced in interurban cars. 1200 w. St Ry Jour—Oct. 1, 1904. No. 65405 C.

Conduit.

South London Conduit Tram Lines. Illustrates and describes the reconstruction of these tramways on the conduit system. 3500 w. Engr, Lond—Sept. 23, 1904. No. 65451 A.

Current Consumption.

Economy in Consumption of Current.

Peter Fisher. Read before the Munic. Tram. Assn., Liverpool, England. Discusses the subject generally and gives information received in reply to a set of questions circulated. 7800 w. Tram & Ry Wld—Oct. 13, 1904. No. 65828 B.

Development.

Street Railways During the Last Decade. A brief sketch of the steps by which this industry has grown since 1894. 6000 w. St Ry Jour—Oct. 8, 1904. No. 65456 C.

Double-Deck.

Double-Deck Cars for Twin Cities Illustrated description of a double-deck trolley car for use between St. Paul and Minneapolis. 500 w. St Ry Rev—Oct. 13, 1904. (Daily Ed.) No. 65595 C.

Electrical Equipment.

Maintenance and Inspection of Electrical Equipment. John Lindall. Read before the Am. Ry. Mech. & Elec. Assn. Suggestions, with a brief description of inspection and repairs of electrical equipment on the Boston Elevated Ry. 2500 w. St Ry Rev—Oct. 12, 1904. (Daily Ed.) No. 65547 C.

Gearing.

Worm Reduction in Electric Tramway Equipments. O. F. Domon. Illustrates and describes a new car with worm reduction gear recently placed on the Seebach-Oerlikon-Zurich Electric Tramway for trial. 1000 w. Elec Rev, Lond—Oct. 21, 1904. No. 65847 A.

Hydro-Electric.

Hydraulics in Connection with Electric Railway Work. B. E. Morrow. A general discussion of the advantages of water power for this work, and the points needing attention in such a plant. 3000 w. St Ry Rev—Sept. 20, 1904. No. 65474 C.

Illinois.

McKinley Syndicate Properties of Central Illinois. Describes properties, including city and suburban lines, which will eventually reach from Danville to St. Louis. 5500 w. St Ry Rev—Sept. 20, 1904. Serial. 1st part. No. 65475 C.

Instruction Car.

An Underground Instruction Car. Illustrated description of the car equipped for the Subway Division of the Interborough Rapid Transit Co., of New York. 900 w. Loc Engng—Oct., 1904. No. 65416 C.

Locomotive.

Electric Goods Locomotive. Illustrated description of a locomotive for service on the electrified branch of the North-Eastern Railway Company's system at Newcastle. 800 w. Engng—Oct. 14, 1904. No. 65692 A.

Mixed Traction.

Methods of Dealing with Mixed Systems of Traction. A. L. C. Fell. Read before the Liverpool Cong. of the Munic. Tram. Assn. of Gt. B. Considers temporary mixed traction during reconstruction; mixed traction under normal conditions; and mixed traction in connection with running powers. 2000 w. Elec Engr, Lond—Oct. 7, 1904. No. 65584 A.

Mountain Railway.

The Stansstad-Engelberg Electric Railway. Emile Guarini. An illustrated detailed description of a narrow-gauge, mountain electric railway in Switzerland. 2000 w. R R Gaz—Vol. XXXVII., No. 18. No. 65557.

New Jersey.

Some Operating Features of the Electric Railway System Controlled by the Public Service Corporation of New Jersey. A. H. Stanley. Illustrates and describes the property of this company, its equipment and operation. It comprises 550 miles of overhead trolley system. 5000 w. St Ry Rev—Sept. 20, 1904. No. 65472 C.

N. Y. Subway.

Opening of the New York Rapid Transit Subway. An illustrated article dealing mainly with the great power station at Fifty-ninth Street and the North River. 2000 w. Sci Am—Oct. 29, 1904. No. 65818.

Passenger Stations and Engineering Details of the New York Subway System. An illustrated detailed description of many interesting features. 5000 w. St Ry Jour—Oct. 1, 1904. No. 65404 C.

The Electric Generating Equipment and Power Distribution System of the New York Rapid Transit Subway. L. B. Stillwell. A full illustrated description of the details of this system, with related information of interest. 5000 w. St Ry Jour—Oct. 8, 1904. No. 65458 C.

The Steam Generating and Engine Equipment of the Power Plant. John Van Vleck. An illustrated detailed description of the construction and equipment of the power plant for the New York Rapid Transit Subway. 9500 w. St Ry Jour—Oct. 8, 1904. No. 65457 C.

Underground Rapid Transit in New York City. Begins a detailed description of this great engineering work. The present number outlines the routes, and begins an illustrated description of the power plant, and its equipment. 8000 w. Elec Wld & Engr—Oct. 8, 1904. Serial. 1st part. No. 65494.

Northampton.

Northampton Electric Tramways. Illustrated detailed description. 3500 w.

Tram & Ry Wld—Oct. 13, 1904. No. 65826 B.

Oregon.

The Territory, Construction, Power Transmission System and Rolling Stock of the Oregon Water Power & Railway Company. Begins an illustrated detailed description of an electric system having many interesting features, and carrying on a large passenger and also freight business. 5800 w. St Ry Jour—Oct. 22, 1904. Serial. 1st part. No. 65675 C.

Overhead Equipment.

Overhead Equipment: Notes on its Construction and Maintenance. J. M. McElroy. Read at the Liverpool Congress of the Munic. Tram. Assn. of Gt. Britain. Discusses the best and most suitable methods of constructing and maintaining the equipment. 3500 w. Elec Engr, Lond—Sept. 30, 1904. No. 65522 A.

Power Station.

See Electrical Engineering, Generating Stations.

Railway Motors.

See Electrical Engineering, Motors.

St. Louis.

The Electric Railways of St. Louis. An illustrated article giving a brief summary of the situation. Also an illustrated description of the new central sub-station of the St. Louis Transit Company, by Charles A. Hobein. 3300 w. St Ry Jour—Oct. 8, 1904. No. 65455 C.

Signals.

Automatic Electric Block Signals. Mellen C. M .Hatch. Illustrates and describes a system recently installed between Oakland and Port Costa, California, explaining its operation. 3000 w. Cal Jour of Tech—Sept., 1904. No. 65509 C.

The Block Signal and Interlocking Systems of the Subway Division of the Interborough Rapid Transit Company. An illustrated detailed description of the electro-pneumatic system installed and the conditions it was designed to meet. 6000 w. St Ry Jour—Oct. 8, 1904. No. 65460 C.

Single-Phase.

Single-Phase Electric Traction (La Traction par Courant Alternatif Simple). An illustrated account of the Spindlersfeld-Niederschöneweide line, describing the Winter-Eichberg motor, with diagrams of tests. 1800 w. Génie Civil—Oct. 8, 1904. No. 65722 D.

Steel Cars.

Fireproof Cars—New York Subway. Illustrated description of the steel passenger cars and the difficulties overcome in their construction. 1500 w. Am Engr & R R Jour—Oct., 1904. No. 65412 C.

Steel Cars for the New York Subway. A statement of the conditions to be considered in designing cars for the subway, with brief description of the first cars built, and illustrated description of the later cars designed by George Gibbs, which are almost entirely of steel. 1500 w. R R Gaz—Sept. 30, 1904. No. 65367.

The New Steel Cars for the Subway Division of the New York Interborough Rapid Transit Company. Reviews the development of the designs for the rolling stock equipment, stating the conditions, and giving an illustrated detailed description of the absolutely fire-proof cars finally evolved. 5500 w. St Ry Jour—Oct. 8, 1904. No. 65459 C.

Steel Track.

Hadfield's Special Steel Track-Work. Illustrated description of street railway track work on the conduit system recently laid in South London. Also editorial. 2000 w. Engng—Sept. 23, 1904. No. 65449 A.

Switzerland.

The St. Gallen, Speicher, Frogen Electric Railway (Die Strassenbahn St. Gallen-Speicher-Frogen). S. Herzog. Describing a Swiss interurban road about six miles long, taking the current from the generating station at Kubel. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 17, 1904. No. 65702 D.

Third Rail.

Third-Rail System of the Scioto Valley Traction Co., Columbus, Ohio. Illustrates and describes the interesting features of this high speed electric road. 7500 w. St Ry Rev—Sept. 20, 1904. No. 65471 C.

Three-Phase.

The Ganz Three-Phase Electric Railway System. G. Leve. A discussion of the advantages and disadvantages of the three-phase motor, and information concerning the Valtellina line. Ills. 3300 w. R R Gaz—Vol. XXXVII., No. 16. No. 65369.

Trucks.

Electric Traction Trucks. Elmer E. Cook. Describes the main types of trucks in use, with some account of their performances. Ills. 5600 w. Trac & Trans—Oct., 1904. No. 65535 E.

Underground.

The London Underground Railways. Map, with description of improvements being made to facilitate transit of passengers. 2800 w. Ry Age—Oct. 21, 1904. No. 65662.

See also Railway Engineering.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Public Works. *m.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Boiler Construction.

Boiler Construction. By Frank B. Kleinhans. Size, 8 by 5½ in.; pp. 421; plates, 5; figures, 334. Price, $3. New York: The Derry-Collard Co. London: The Locomotive Publishing Co., Ltd.

As indicated by its secondary title, this book contains "a practical explanation of the best modern methods of boiler construction from the laying out of sheets to the completed boiler." It is essentially practical and goes thoroughly into the details of the various operations described, so that anyone mastering it should have as correct an idea of boiler construction as is possible without actually seeing the work done. The locomotive boiler is taken as an example of steam boilers in general, as it is in such extensive use, and as its design and construction present perhaps more difficulties than those of any other type, and anyone capable of following some of its complicated sheets from the laying-out bench through the hydraulic press and the riveting machine to the finishing processes will be able to handle the sheets of other styles of boilers. The different operations are taken up in regular order, beginning with the laying-out of the sheets. Flanging, forging, shearing, planing, punching, bending, riveting, and all the other processes are minutely set forth, and the boiler details are carefully described, as are also all the tools and machines used in boiler construction. Line drawings and half-tones, in the text and on plates, supplement the descriptions, and many tables of useful data and an index add to the value of a very up-to-date work.

Drawing.

Elements of Plane and Solid Free-Hand Geometrical Drawing, with Lettering and Some Elements of Geometrical Ornamental Design. By S. Edward Warren, C. E. Size, 8 by 5 in.; pp. 137; 12 plates, and many figures in the text. Price, $1 (4s. 6d.). New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Drafting Instruments and Operations. By S. Edward Warren, C. E. Size, 8 by 5 in.; pp. 152; 100 figures and 7 plates. Price, $1.25 (5s. 6d.). New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Elementary Projection Drawing, Theory and Practice. By S. Edward Warren, C. E. Size, 8 by 5 in.; pp. 162; 24 plates, and figures in the text. Price, $1.50 (6s. 6d.). New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Elementary Linear Perspective of Form and Shadow. By S. Edward Warren, C. E. Size, 8 by 5 in.; pp. 121; figures, 67; plates, 2. Price, $1 (4s. 6d.). New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Many college generations of students are familiar with Prof. Warren's treatises on descriptive geometry, shades and shadows, stone-cutting and other higher branches of mathematical drawing, and have had their imaginations quickened and their reasoning powers strengthened by the exercises and problems there presented, and some of them have also made the acquaintance of his more elementary works. All of these men will welcome the appearance of new editions of the works under review, which form the four parts of a series on Industrial Science Drawing, and also serve as an introduction to the author's more advanced writings; and the student and draftsman of to-day will find in these books a systematic course of instruction founded on the principles which have been instrumental in training many of the greatest engineers of the age. While following the broad lines laid down in the earlier editions, which have been so successful in the past, the present works have been revised to meet the needs of the changing times. The titles of the volumes are a sufficient indication of their general contents, and where there is so much of value, it is difficult to single out special features for treatment in such a limited space, but one subject, which it is unusual to find in a work of this kind, may be mentioned: Part III. of the book on Free-Hand Geometrical Drawing is devoted to the "Elements of Geometric Beauty," and contains several chapters on the æsthetic aspects of drawing, geometry and architecture which are most interesting and suggestive. It is hardly necessary to add, with the names that appear on the title pages, that the mechanical execution of these volumes is up to the high standard of their subject matter.

Electricity.

Modern Practical Electricity. Electricity in the Service of Man. A Popular and Practical Treatise on the Application of Electricity in Modern Life. By R. Mullineux Walmsley, D. Sc. (Lond.), F. R. S. E. Four volumes. Size, 10 by 7 in.; pp. 1240; 1208 illustrations in the text and a number of plates. Price, $12 for the set. Chicago: W. T. Keener & Co.

The marvellous increase in the applications of electricity to the service of man is perhaps the most striking phenomenon of the last quarter century, and it is but a commonplace to say that everyone should know as much as possible about electrical science and its practical developments. The question is, how to acquire this knowledge. Most people have neither the opportunity nor the inclination for a lengthy course of study or a working apprenticeship, and must get their information, if at all, from books which they can read in their leisure moments. To all such persons the work under review may well appeal, for it is both "a popular and practical treatise on the applications of electricity in modern life." It is scientifically sound, but is not too technical for the average man, and it covers a very great deal of ground in an effective manner. The work is divided into two main parts, "the history and principles of electrical science" and "the technology of electricity." The former contains an excellent review of the development of the various branches of the science and its practical applications, bringing the accounts right down to the present time and describing the most modern, as well as the historical apparatus and machines. The second part goes more into the details of present-day electrical engineering, but in a plain, straightforward way which can be understood by the general reader as well as by the student. A profusion of diagrams and illustrations adds greatly to the value of the volumes, and an index completes a work which is really encyclopedic in scope.

Heat Losses.

Practical Laws and Data on the Condensation of Steam in Covered and Bare Pipes, to which is added a Translation of Péclet's "Theory and Experiments on the Transmission of Heat Through Insulating Materials." By Charles P. Paulding, M. E. Size, 9 by 6 in.; pp. 102; figures, 185. Price, $2. New York: D. Van Nostrand Company.

More than half a century ago the French physicist Péclet made extensive researches on the radiation of heat from different surfaces and the conduction of heat through various materials. The laws and formulæ which he deduced from his investigations form a theory of these phenomena which serves well as a basis for tests along these lines, and the most recent experiments on the loss of heat from covered and bare steam pipes give results in agreement with his work. Although Péclet's general conclusions have long been known to English-speaking engineers, it remained for the author of the present book to give a complete translation of those parts of Péclet's "Treatise on Heat" which have a direct bearing on practical problems of the present day, and to show how the French physicist's methods may be applied in steam engineering and heating work. Some of the latest tests on the loss of heat from covered steam pipes are here compared and discussed, and tables and curves are given which will do much to facilitate and systematize further investigations, the author's experience having qualified him to determine what is most useful to engineers in these fields.

Naval Architecture.

Naval Architecture. By Cecil H. Peabody. Size, 9 by 5¾ in.; pp. v, 616; figures, 217. Price, $7.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Recognizing the fact that if America is to build up her navy and her mercantile fleet she must have trained naval constructors and marine engineers, several of the great technical schools of the United States have organized courses in naval architecture, and it is the head of this department at the Massachusetts Institute of Technology who is the author of the present volume. While designed primarily as a text book, this work will be found very useful by naval architects and shipbuilders in general, as it develops its subject in a clear and logical manner, establishing the principles of naval architecture and showing their practical application by many appropriate examples. The opening chapter gives the various methods for computing areas, and a discussion of graphical integration and of mechanical integrators. The subjects of displacement, center of buoyancy and stability are then taken up, and next comes a complete discussion of surfaces of buoyancy and water-lines. Then follow chapters on adding and moving weights, on grounding and docking and on launching, in which the different kinds of docks and ways of launching are described, and the methods for determining displacement and stability extended and applied to these operations. There is a comprehensive treatment of the theory of waves, and also a discussion of the rolling of ships, including a description of experiments on a large scale and of means for diminishing rolling. The chapters on the resistance of ships, the propulsion of ships and power for ships form a very important portion of the book, and contain a great deal of valuable matter, including a discussion of the screw propeller. Steering and manœuvring, including a description of different forms of rudders, take up another section, and the final chapter is devoted to the weight and strength of ships. Many diagrams and tables help to elucidate the text. and the work is completed by an index.

Printing.

Concerning Type. A Hand-Book of Useful Information for Advertisers and Users of Printing. By Ambrose S. Carnell. Size, 6 by 3 in.; pp. 64; illustrations. Price, 50 cents. New York: Ambrose S. Carnell.

Besides being the "art preservative," printing might lay claim to the title of the art conservative, for it is permeated with traditions and terms handed down from remote antiquity, but even this art must grow with the growing age, and among the innovations of recent years has been the adoption of the "point system" by all the typefounders of the United States, which has brought about an absolute uniformity of the different sizes of type, instead of having a variety of standards, as under the old lack-of-system, when each founder had his own idea as to the proper sizes for nonpareil, brevier, long primer and the rest. Styles of type change, too; new faces are designed and the old ones become modified. Exact information concerning these developments, which has heretofore been scattered in many places, more or less inaccessible, has now been gathered together in convenient form in the present hand-book. But this book not only tells about type, but also contains some account of half-tones, line-cuts and electrotypes, a glossary of printing terms, advice about "copy," proofs, and proofreading, tables giving the number of ems to the square inch for different sizes of type, approximate number of words to the square inch, amount of paper required for a job, sizes of paper and envelopes, and a great deal of other information essential for both printer and editor.

Rapid Transit.

Interborough Rapid Transit: The New York Subway; Its Construction and Equipment. Size, 13½ by 10 in.; pp., 150. Many illustrations. New York: Interborough Rapid Transit Company.

The opening of the underground railway in New York affords an appropriate occasion for the appearance of this elaborate souvenir publication, which, by illustration and text, describes all the features of the great undertaking. As is well known, the Rapid Transit Railway, or Subway, for which New Yorkers have waited so long, extends from the City Hall and the Brooklyn Bridge to Kingsbridge, just north of Spuyten Duyvil Creek, a distance of 13½ miles, with an easterly branch about 7 miles long, which leaves the main line near 103d Street and runs under the Harlem River to Bronx Park. There is also under construction an extension of the road to Brooklyn, about 3 miles in length, which runs from the City Hall down Broadway to South Ferry and under the East River to a terminus at Flatbush and Atlantic avenues. The greater part of the road is under ground, but about two miles in the upper part of Manhattan Island and three miles in the Borough of the Bronx are on viaduct. The present book opens with a historical and general review of the Rapid Transit Road, and then takes up the various parts of the enterprise, including the underground construction, the track, the signal system, the cars and their equipment, the great power station and other features. All of these are fully and interestingly described, and beautifully illustrated, and the whole execution of this souvenir volume is worthy of the great engineering work to which it is devoted.

Wireless Telegraphy.

Maxwell's Theory and Wireless Telegraphy. Part I: Maxwell's Theory and Hertzian Oscillations. By H. Poincaré. Translated by Frederick K. Vreeland. Part II: The Principles of Wireless Telegraphy. By Frederick K. Vreeland. Size, 8½ by 6 in.; pp. xi, 255; figures, 145. Price, $2.00. New York: McGraw Publishing Company.

The art of wireless telegraphy has now reached a stage where a comprehensive survey of the principles on which it is based is in order, and such a review of the theory of Hertzian waves and their application to the transmission of intelligence through space forms the subject matter of the present work. The first part of the book is a translation of Prof. Poincaré's luminous exposition of "Maxwell's Theory and Hertzian Oscillations," in which mathematics is practically eliminated, the Maxwellian equations being converted into the language of every-day life, and illustrated by mechanical analogies and diagrams, most of the latter having been especially prepared by the translator. In the second part the application of the fundamental principles of electrical science to space telegraphy is taken up, the development of the subject being continued in a logical manner, and the two parts of the treatise being so well matched that no break in the continuity of the story can be observed. While no attempt has been made to catalogue the innumerable devices which have sprung up with the growth of the art, the typical systems and pieces of apparatus are well described wherever they are necessary to the general development of the subject. In this second part, after the introductory and historical portion, there are chapters on the grounded oscillator; propagation of grounded waves; the receiving apparatus, and selective signaling. The chapter on grounded waves gives an excellent discussion and summary of the hypotheses concerning the modus operandi of the electric waves between the transmitter and the receiver, and the other chapters are no less clear and interesting, emphasizing the essential and omitting the superfluous. The translation of Prof. Poincaré's monograph is very well done, both technically and from the point of view of style, and the whole work gives a remarkably good treatment of the theory of electric waves and their application to wireless telegraphy, in a manner which is scientific in the best sense of the word.

BOOKS RECEIVED.

The Industrial and Artistic Technology of Paint and Varnish. By Alvah Horton Sabin. Price, $3. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Types and Details of Bridge Construction. Part I. Arch Spans. By Frank W. Skinner. Price, $3. New York: McGraw Publishing Company.

Forge Practice. By John Lord Bacon. Price, $1.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Alternating Current Engineering Practically Treated. By E. B. Raymond. Price, $2.50. New York: D. Van Nostrand Company. London: Kegan Paul, Trench, Trübner & Co., Ltd.

An Introduction to the Modern Theory of Equations. By Florian Cajori, Ph. D. Price, $1.75. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

The Art of Wise Investing, Price, $1. New York: Moody Publishing Co.

The "Mechanical World" Pocket Diary and Year Book for 1905. Price, 6d (25 cents). Manchester, Eng.: Emmott & Co., Ltd.

Electrical Lighting: A Practical Exposition of the Art. Volume I. The Generating Plant. By Francis B. Crocker. Sixth edition. Price, $3. New York: D. Van Nostrand Company. London: E. & F. N. Spon, Ltd.

The Electrical Transmission of Energy: A Manual for the Design of Electrical Circuits. By Arthur Vaughan Abbott. Fourth edition. Price, $5. New York: D. Van Nostrand Company. London: Crosby Lockwood & Son.

Reinforced Concrete. By Charles F. Marsh. Price, $7. New York: D. Van Nostrand Company.

Mechanical Appliances, Mechanical Movements, and Novelties of Construction. By Gardner D. Hiscox. Price, $3. New York: The Norman W. Henley Publishing Company.

Tractive Power Chart. Price, 50 cents. New York: The Derry-Collard Co.

British Sewage Works. By M. N. Baker. Price, $2. New York: The Engineering News Publishing Company.

Scientific American Reference Book. Compiled by Albert A. Hopkins and A. Russell Bond. Price, $1.50. New York: Munn & Company.

Elements of Mechanical Drawing. By Alpha Pierce Jamison. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Earth Dams. By Burr Bassell. Price, $1. New York: The Engineering News Publishing Co.

Electrical Engineering Experiments and Tests of Direct Current Machinery. By George F. Sever. Price, $1. New York: D. Van Nostrand Company.

Experiments with Alternate Currents of High Potential and High Frequency. By Nikola Tesla. New edition. Price, $1. New York: McGraw Publishing Company.

Self-Propelled Vehicles. By James E. Homans. Second revised edition. Price, $2. New York: Theo. Audel & Co.

Friction and Lubrication. By Wm. M. Davis. Second edition. Price, $2. Pittsburg: The Lubrication Publishing Co.

Twentieth Century Hand-Book for Steam Engineers and Electricians. By C. F. Swingle. Electrical Division, by Henry C. Horstmann and Victor H. Tousley. Price, $2.50. Chicago: Frederick J. Drake & Co.

Untechnical Addresses on Technical Subjects. By James Douglas. Price, $1. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Australian Mining and Metallurgy. By Donald Clark. Price, 21s. Melbourne, Sydney and Perth: Critchley Parker.

The Architects' Directory and Specification Index for 1904-05. Price, $2. New York: William T. Comstock.

Report of the Proceedings of the Thirty-seventh Annual Convention of the American Railway Master Mechanics' Association. Jos. W. Taylor, Secretary, 667 Rookery, Chicago.

Commercial Relations of the United States with Foreign Countries During the Year 1903. Bureau of Statistics, Department of Commerce and Labor, Washington, D. C.

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THE PRESENT ASPECTS OF THE PANAMA CANAL.

By Wm. H. Burr.

The construction of the Panama Canal is the largest practical undertaking involving the use of excavating and conveying machinery which is before the engineering world today. Professor Burr reviews the subject altogether in his private and individual capacity; but as a member both of the Isthmian Canal Commission of 1899 and of the present Commission charged with the construction of the waterway, he stands in the forefront of the engineers who are thoroughly familiar with the elements of the problem and the conditions to be met.—THE EDITORS.

INASMUCH as it is scarcely nine months since the present Isthmian Canal Commission was created, and as the first month and a half of that time was nearly wholly occupied in its first visit to the Isthmus for the purpose of inspecting the work about to be acquired by the United States, any view of the Panama Canal project at this early date must be a consideration of what has been transmitted from the new Panama Canal Company to the United States government rather than a review of plans adopted or of methods of construction for the great work undertaken. Indeed, it must be borne in mind that the title of the Panama Canal property was actually transferred to the United States government only on May 4, 1904, so that the Commission has been in control of the canal property but seven months at this writing.

The full report of the former Isthmian Canal Commission of its work performed "with a view to determining the most practicable and feasible route for" a ship canal across the American Isthmus, is a complete compendium not only of all data existing at that time regarding the canal property, but also a comprehensive statement of the plans and estimates of that Commission regarding the type of canal recommended by it. The conditions under which the canal is to be built and the character of the ocean traffic to be accommodated have

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changed so radically within the period elapsed since the old Panama Canal Company went into bankruptcy that the work before the present Isthmian Canal Commission must necessarily be largely independent of anything hitherto contemplated, and its plans must be developed and completed for practically an entirely new project. This is a necessary procedure for a number of important reasons. Among others, during the past three years, even, material developments in the size and motive power of steamships have been made and those developments are in active progress at the present time. Steamships over 700-feet long have been built and there are already serious statements from ocean transportation companies regarding the building of ships approaching 800 feet in length. Loaded vessels have entered or left the harbor of New York with a draft of 32 or 33 feet and possibly a little more. For these general reasons, the former Commission prescribed a bottom width of 150 feet for the canal and a depth of water of 35 feet. Although it is not probable that the greatest ships afloat will, immediately after its completion, seek the Panama Canal, it is practically certain that the opening of such a canal will shift some lines of ocean traffic and stimulate others, so that it is a measure of wisdom only to follow the instructions given to the former Commission and tacitly at least to the present Commission, to construct a waterway which shall afford accommodation for the largest ships afloat.

The Panama Canal line will be practically identical with that first adopted by the old Panama Canal Company and subsequently accepted by the new Panama Canal Company. There will certainly be some modifications of details of alignment, but in the main the French location was well considered and the canal will be built upon it. There is still an open question as to the advisability of what is known as the Tiger Hill alternative, which was so strongly advocated by the late Mr. George S. Morison, member of the former Commission. This alternative line was originally surveyed and located by Commander Lull, U. S. N., in 1875. It covers that portion of the canal location between Gatun, about six miles from Colon, and Bohio, about 17 miles from the same point. It is a shorter line than the French location by about one mile and a quarter. It also has the advantage of moving the canal line away from the Chagres River to the foot of the high ground easterly of that river, and throughout a portion of its length materially higher than the low marshes along the course of the river. It has two disadvantages; one, that the excavation of the old Panama Canal Company between Gatun and Bohio would be abandoned, necessitating a correspondingly increased amount of new excavation; and the other, that the canal prism would be carried for a considerable distance between Tiger Hill and Bohio within an embankment attaining a height in some places of nearly or quite 20 feet and resting on soft ground. The necessary data for the determination of this and other features of modified alignment have been already largely secured, enabling such questions to be satisfactorily answered in the near future.

The total length of the Panama canal between six-fathom curves in the two oceans is 49.09 miles, of which about 17 miles on the Caribbean side and 8½ miles on the Pacific side, i. e., practically one-half the length of the canal, is to be excavated through low marshy ground little above sea level. These two portions of the line constitute the Atlantic and Pacific sea levels in the plans of the new Panama Canal Company as well as of the former Isthmian Canal Commission. This is an important feature of the project, especially in considering ultimately whether a sea-level canal or canal with locks shall be built, for it indicates that in any event a little more than one-half of the canal will be a sea-level waterway. Will it then be advisable to give to the remainder (less than half the length) the same freedom from restriction of locks to navigation?

The intermediate 24 miles of canal line cover the higher portions of the low saddle in the Cordillera at the Panama crossing. The highest point in this saddle before any excavation was made at Culebra was about 330 feet above mean sea level. The length of this deepest canal cutting through Culebra Hill is scarcely 3,000 feet. Strictly speaking, the heavy part of the summit cut, comprising what is ordinarily known as the Emperador and Culebra Cuts, is not more than six miles in length and its original surface elevation with the exception of the Culebra portion averages about 175 feet above mean sea level. The natural slope from the Culebra Cut toward the Pacific is relatively abrupt, it being but four miles from the cut to Miraflores, at which both the former Commission and the new Panama Canal Company located their first lock on the Pacific side of the Isthmus. The slope from the northerly end of the summit cut at Emperador toward the Caribbean is relatively gentle, the distance from Emperador to Bohio, where the new Panama Canal Company and the former Commission located the first lock on the Caribbean side of the Isthmus, being sixteen miles. No well developed plans for either of the terminal harbors have been made up to this time but such plans are now being thoroughly considered by the present Commission.

The old Panama Canal Company which began its operations in 1881 planned a sea-level canal having a depth of water of 29.5 feet and bottom width of 72 feet. It carried on work actively until 1889 when it suspended operations and went into bankruptcy, its excavations amounting to a total of about 72,000,000 cubic yards. The new Panama Canal Company has excavated about 8,000,000 cubic yards since that time. The work of excavation of the old company was distributed over parts of the entire line, although there were considerable portions of the line on which no excavation at all was made. Over some other portions of the location relatively small quantities of material only were taken out. The largest parts of this work were performed within about 12 miles of Colon, within about 5 miles of Panama, and within a distance of about 7 miles including the great Culebra and Emperador Cuts. The excavation along the sea-level portions of the canal at either end was all made in soft ground, but in the excavation in the Emperador and Culebra Cuts as well as at Obispo, near the point where the Chagres River first cuts the line of the canal as it flows toward the sea, considerable rock was found, some of it being dense and hard. In addition to this work of actual excavation, the French companies, especially the new Panama Canal Company, accumulated a large amount of available information regarding the subsurface material and depth of bed rock at many points along the line. The examinations, including jet borings at the proposed Bohio and Gamboa dam sites and for the proposed dam at Alhajuela higher up the river, are included in this portion of their operations. The performance of this large amount of excavation work and the investigations disclosing information regarding the subsurface materials, have largely revealed with certainty the character of the greater part of the work to be done in completing a ship canal. In other words, they reduce materially those exigencies of such a great work which consume time and add to the cost.

Of the total excavation hitherto made and amounting to about 80,000,000 cubic yards, probably not more than one-half will be available in the construction work to be planned by the present Commission. This, however, constitutes an available asset of much value.

There is another asset available to an uncertain extent in the immense quantity of material and plant left largely in well kept warehouses but otherwise spread along the entire line in an exposed condition. The apparent book value of all this material as shown in the records of the new Panama Canal Company is about $29,000,000. By far the greater part of this value is now imaginary only. A considerable part of the plant and a large amount of the material in the warehouses can, however, be brought into condition of much value as the work progresses. Indeed, several of the old bucket dredges, a large number of dump cars, and various other plant, including a most useful machine shop at Matachin, have already been repaired and put into service by Mr. John F. Wallace, the chief engineer of the Commission. The present Commission has thus come into control of a great ship-canal work, a small portion only of which has been performed, and with the greater part of the data required for the ultimate solution of all its problems yet to be determined. These problems include first of all the answer to the main question, whether the canal shall be a sea-level canal or of the lock type. Whether one type or the other be adopted, they cover also such great features of the work as the interior harbor at the Colon or Cristobal entrance to the canal and possibly the exterior harbor lying outside of it, the control of the Chagres River in times of flood, involving the construction of probably a great dam at Bohio or at Gamboa and possibly a tunnel through the Cordillera to divert the waters of the Chagres River toward the Pacific Ocean, additional harbor facilities at the Ancon or Panama end of the canal, the elevation of the summit level if a canal with locks should be built, and the number, location, and lift of those locks. Manifestly, the solution of some of those problems must depend upon the rate at which excavation can be made either in rock or in earth and its unit cost. Further than this, in the event of building a lock canal it is highly probable that a great dam will be required across the Chagres near Bohio, whose construction would involve unprecedented methods upon a large scale in consequence of the great depth of bed rock at that place.

Preparation for construction was begun by the Commission last May by organizing engineering field parties which sailed from New York during June and the early part of July. At the same time Mr. John F. Wallace, formerly general manager of the Illinois Central Railroad Company, past president of the American Society of Civil Engineers; was appointed chief engineer of the Isthmian Canal Commission, and he entered upon his duties the latter part of June. There were five of these parties beside the engineering force organized for the purpose of designing and constructing water works and sewer systems for the cities of Panama and Colon.

Taking these forces in the order of their location from Cristobal, the American port at the Caribbean end of the canal, the first is located at that point. This party is charged with the duty of making all the requisite surveys and investigations, including jet borings, both on land and water, needed for the development of the complete plans for the interior harbor at the mouth of the canal, for the deep-water channel leading to it from the harbor of Colon, and for any advisable re-alignment of that portion of the canal between Cristobal or Colon and Gatun about six miles inland. The second party was entrusted with the surveys and investigations required to determine the feasibility of building a dam across the Chagres valley at Gatun and to ascertain whether it is desirable to confirm the location of the French companies between Gatun and Bohio, or to adopt the Tiger Hill alternative between those points. The third party has undertaken to make exhaustive investigations, including surveys, necessary for the location of a dam across the Chagres near Bohio, also to make certain other surveys connected with some minor details of re-location in the same general vicinity. This party is making many jet borings on a number of profiles so as to secure complete information regarding the deep bed rock under the river. In this manner the most favorable location for the Bohio dam, should it be constructed, may be conclusively determined. The fourth party has been assigned to the responsible duty of making extensive surveys and other investigations from Gamboa, where the Chagres River and canal line intersect about 30 miles from Colon, 12 miles or more up the Chagres valley. This work will cover the continental divide at the summit of the Cordillera, the southerly limit of the Chagres watershed, and the divide constituting the northerly limit of the same shed; it will include also the numerous borings to bed rock at the Gamboa dam site and at other points. It will disclose the information requisite for the determination of plans for effectively controlling the flood flow of the Chagres River. The data already obtained show that it is entirely feasible to build a dam at Gamboa and to divert a portion, or all, of the waters of the Chagres to the Pacific through a tunnel not more than 7 miles long, or toward the Caribbean Sea through a tunnel piercing the other divide and about 4 miles long, the former probably being preferable. The surveys of the French companies failed to disclose any location for a tunnel less than 10 miles long through the Cordillera towards the Pacific.

The new Panama Canal Company had a labor force of about 700 men engaged in excavation at the great Culebra Cut when the canal property was turned over to the present Commission in May last. The organization of this force and plant has been maintained and greatly increased in efficiency. The fifth field party was assigned to such engineering work in connection with this great excavation as will be required for its ultimate execution and in making the final location in the vicinity of Culebra. This force has also been instrumental in installing a system of field accounts, so that a complete daily record may be kept of progress and cost of all classes of work.

All of these parties have conducted the operations assigned to them continuously and energetically. They have secured data of great value in the ultimate solution of the main problems of the project. They are still at work in their several fields, but these preliminary operations are drawing to a close, thus enabling the Commission promptly to study and formulate the final plans on which the work of construction on a large scale depends.

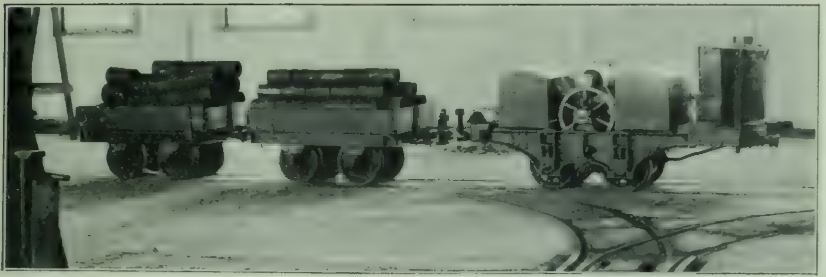
The United States government is required under the treaty made with the Republic of Panama not only to construct complete water works and sewer systems for the cities of Panama and Colon, but also to formulate and execute certain sanitary measures for those cities. In accordance with the terms of the agreement recently reached by Secretary Taft with the Panama government at the city of Panama, complete control of this sanitary work has been vested in the United States government represented by the Isthmian Canal Commission.

The source of public water supply selected for the city of Panama is a reservoir in the upper Rio Grande valley close to the great Culebra Cut and about 10 miles from the city. The dam for this reservoir was constructed in the days of the old Panama Company by M. Philippe Bunau-Varilla, chief engineer, and subsequently the first Minister Plenipotentiary from the Republic of Panama to the United States. This is an interesting example of a curved concrete dam built in a few days time and containing little masonry, yet it has proved admirably adapted to its purpose. This dam will be raised and strengthened so as largely to increase the capacity of the reservoir. A 16-inch cast-iron pipe will convey the water to a distributing reservoir at Ancon, in the canal zone, at a suitable elevation on the north-eastern slope of Ancon Hill immediately adjacent to the city of Panama. The supply has been based upon an estimated daily consumption of 60 gallons per head of population. The distribution system is complete in every particular and adapted to any extension required by the future growth of the city. The construction of this water-works system has progressed so far as to render it practically certain that the city will receive the first public water in its history in February next.

The planning and construction of the sewer system has also been pushed forward as rapidly as possible and it will be completed ready for use soon after the introduction of water. The sewer system is divided into three districts, each having an outfall into the sea water of Panama Bay, at a sufficient distance from the shore to provide abundant dilution. The system is designed to receive the sewerage of the city and a rainfall of about one inch per hour, any excess over the latter being carried off on the surface. When it is remembered that the city of Panama has never before had a sewer system it can readily be appreciated what a sanitary relief both the sewer system and the water supply will be to the city.

The water-supply and sewer systems for the city of Colon have also received the careful attention of the Commission. A suitable source of water, however, has not been so easy to find as at Panama, and the sewer system cannot be constructed until a considerable amount of filling with excavated material from the canal has been completed. Both works, however, will be undertaken and finished in the near future. As the population of Colon is under 6,000 while that of Panama is nearly 20,000, the conditions bearing upon the sanitation of Colon are the more easily controlled pending completion of its water works and sewers.

It may be interesting to observe, although not in line with the actual construction of the canal, that the Commission among its other duties is charged with that of the civil government of the canal zone, a territory 10 miles wide running across the Isthmus with the axis of the canal as its center line, but excluding the cities of Panama and Colon as delimited under the treaty. Major Gen. George W. Davis, U. S. A., retired, member of the Isthmian Canal Commission, is the Governor of the zone, and under his jurisdiction have been organized by the Commission most effective hospital and sanitary forces with Col. W. C. Gorgas, U. S. A., as chief sanitary officer. The great hospital on the slope of Ancon Hill with its 700 beds has been put in excellent working condition, while the sanitary forces of the Commission have already rendered highly effective services toward bringing the entire zone into sanitary condition, especially in the extermination of mosquitoes. Boards of health of high character and excellent quarantine organizations have been established both at Panama and Colon. Although four sporadic cases of yellow fever have occurred in Panama within the last six months, the infection has not spread from any case, in consequence of the vigilance of the medical and sanitary forces. The general health of the Isthmus has been good and there seems to be a certain promise of excellent sanitary conditions hereafter, such as to enable the forces of the Commission to perform their work in safety from epidemics and with the highest degree of efficiency obtainable in the tropics.



Robins Storage-Battery Locomotive in the N. Y. Subway Power House.

MECHANICAL TRANSPORTATION IN THE MODERN MACHINE SHOP.

By Frederick A. Waldron.

This article is not intended by its author to be a technical discussion of the design and construction of the numerous appliances as used in the different methods of shop transportation, but a historical and descriptive treatise on the principal forms of hoisting apparatus as utilized in the modern machine shop.

A NOTED authority on rapid transit stated, a few years ago, "that it was not a struggle for minutes, but for seconds, that would solve the problem." The aggregate capital invested in industrial corporations far exceeds the amounts invested in rapid-transit facilities in large cities, and the problem of "rapid transit" in the modern machine shop is as far-reaching as in the large city.

Thirty years ago, the owner of a machine shop was an investor, who, by prudence, earned a livelihood, or, from some patented monopoly, made a fortune. Today this is changed. The owner of the larger machine shop is a banker, endeavoring to turn his capital over as many times as possible during a year, expecting only a fair interest return on the money which is loaned on labor and materials. To accomplish this result, each unit of product which goes to make the whole must be gotten out of the way as quickly as possible, in order to make room for the next.

Modern methods of management demand prompt and efficient service for the elaborate and expensive machinery in which the owner's money is invested. Further, the systems now in use in compensating employees are such that in order to obtain the best possible results and accurate costs, the element of unforeseen contingencies must be eliminated as far as possible. To accomplish this, brain and muscle are brought to bear on the problem from every direction. The introduction of high-speed steels and the phenomenal increase in the weights of machinery, combined with the premium and piece-rate systems for the purpose of decreasing prime labor costs, are becoming universal; the whole aim is an increased output on plant investment.

The manufacturer of today who is investing heavily in new machinery and high-speed steels, but who does not take into consideration the most efficient methods of mechanical transportation, places his shop in the same position as the freight-storage yard of a large railroad, if left without a switch engine. Of what value are the modern machines and rapid-production methods if a piece of work remains in a machine longer than is required to perform the necessary operations? A terse definition of mechanical transportation, as applied to the machine shop of today, is, "To get what you want, where you want it, when you want it;" and as a general proposition it is wanted right away. To accomplish these results, the traveling crane, industrial railway, jib crane, tram rails, elevators, and chain hoist have assumed as important a place in the modern machine shop as have the high-speed steels and machine tools.

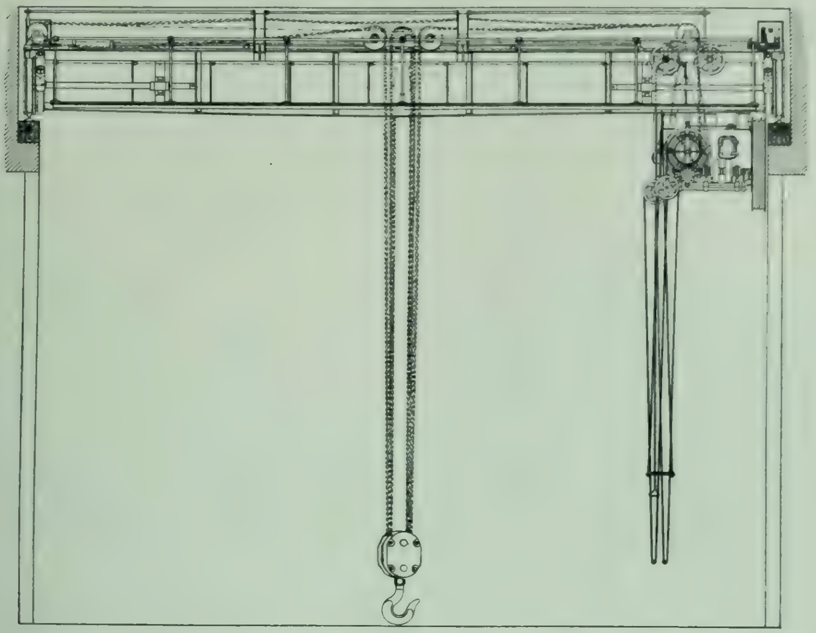
For convenience, the subject will be divided as follows:—

1.—Historical.

2.—Descriptive.
- a Types of Hoists and their characteristics.
- b Selection.
- c Care and Inspection.

3.—Commercial Efficiency.

Historical.—It is not more than twenty-five years ago that the chief organs of mechanical transportation, exclusively resorted to by the machine shops of that period, consisted of a crowbar, screw-jack, a few skids, and gas pipe or hard-wood rollers. The first step in the systematic treatment of the shop-transportation problem was the differential chain hoist, hung from an improvised trolley, gantry, or tram rail. Prior to 1880 there was no systematic attempt in the United States to classify and manufacture, as a regular product, cranes of any description. In 1881-82, the first attempt in this direction was made by Henry R. Towne, who, in a paper read before the American Society of Mechanical Engineers and later published by him in book form (in 1883) brought the classification of cranes to a rational and commercial basis.



FIRST TRAVELING CRANE BUILT BY THE YALE & TOWNE MFG. CO., STAMFORD, CONN., U. S. A.

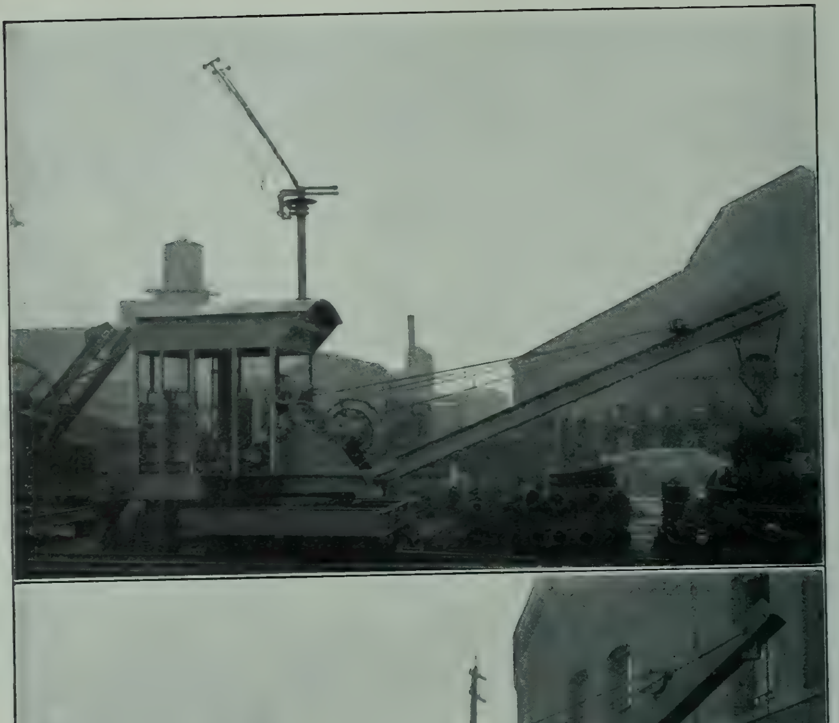
Built in 1882, being one of the first in the United States. Received power from a cotton rope, running the entire length of the shop and driving the rope wheel on the right; trolley travel and hoisting effected by a pitched chain running over pocket wheels; bridge travel by "squaring rope" method, the rope passing around a grip wheel in the crab mechanism.

The locomotive crane and various types of traveling cranes had been made for some years prior to this in England and on the Continent, but Mr. Towne's paper is the first record of any systematic attempt to produce cranes commercially in the United States. Since then the evolution of the power traveling crane has been very rapid, and the epoch-making periods date as follows:—

In 1880-82 the first power travelers were designed with rope drive, squaring rope for bridge travel, and pitch chain for hoisting and trolley travel.

One of the first power travelers manufactured in the United States is shown just above and was built in November, 1882.

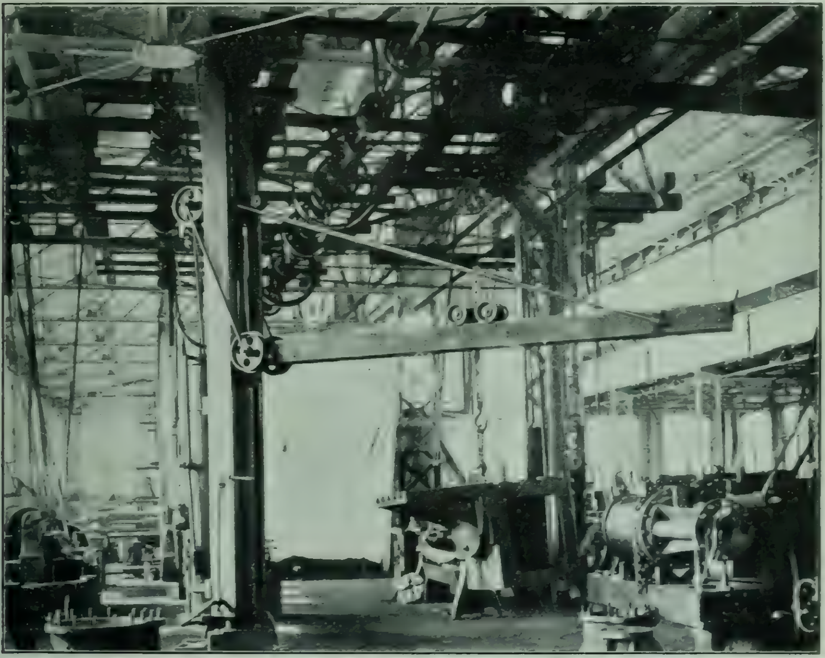
In 1885-88 the square shaft and "tumbling bearings" were substituted for the rope drive; the squaring rope was eliminated, and the truck wheels of the bridge were connected with a pinion shaft, while a self-contained trolley, with hoisting drum contained thereon, was driven by a shaft extending across the bridge.



TYPES OF LOCOMOTIVE CRANES.

The crane in the upper picture, built by the Brown Hoisting Machinery Co., is operated electrically in all its functions—hoisting, rotating, and traveling. The one below, built by the American Hoist & Derrick Co., St. Paul, Minn., is steam-driven; it has a 30-ft. boom, and is of 15-tons capacity at 10-ft. radius. It is shown as installed in the Allis-Chalmers works, Scranton, Pa.

From 1889 to the present day, the traveling crane has been developed exclusively along electrical lines. The first electric crane was built by the E. P. Allis Company, from a design by Alton J. Shaw, who founded the Shaw Electric Crane Company, of Muskegon, Mich., and many of the features contained in this first design are used by the leading crane makers of today. From that time to the present day, the energy of the crane builder has been devoted to the perfection of design and refinement of construction, together with increased wearing capacity for continuous and heavy duty.



A HYDRO-PNEUMATIC JIB CRANE, FOR FOUNDRY AND SHOP USE.

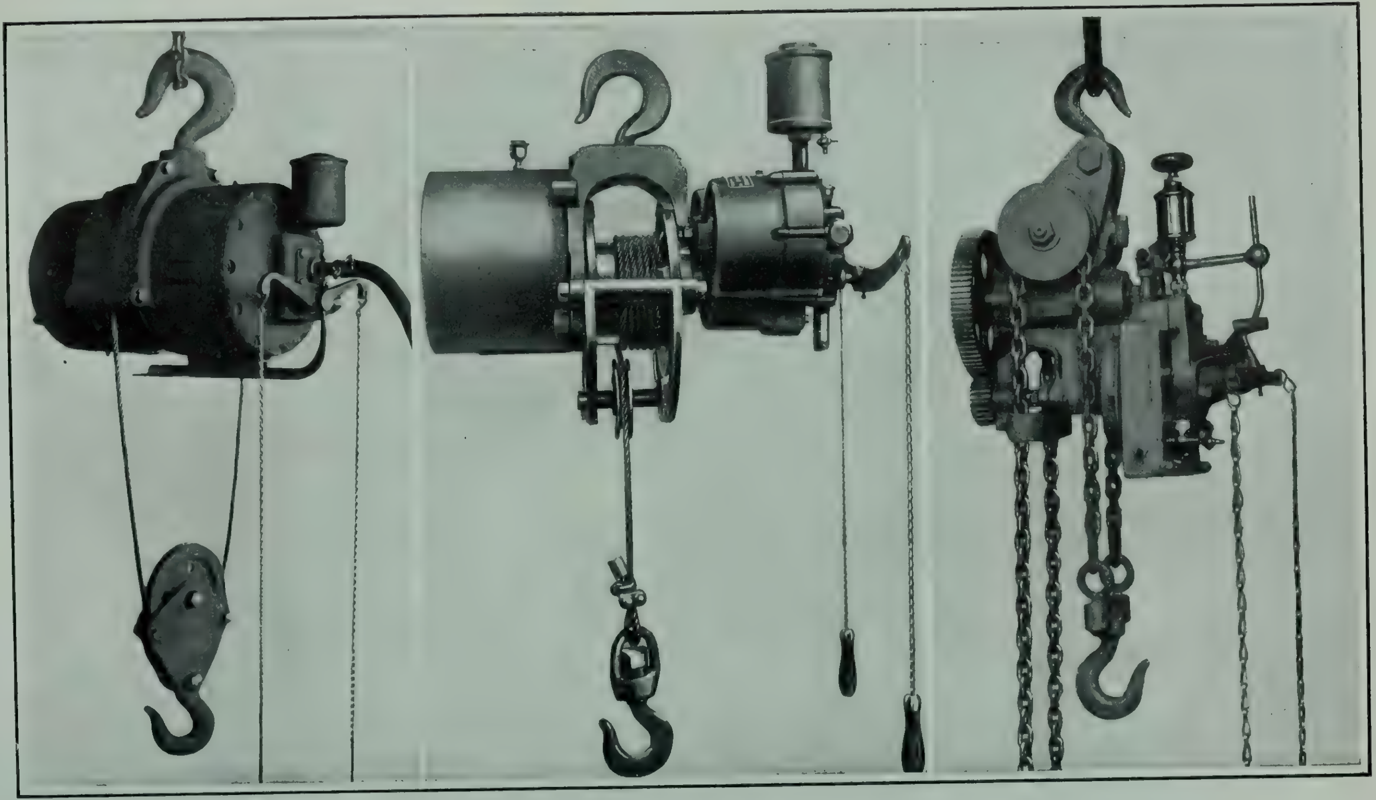
Power is applied by putting air-pressure on the water in a cylinder at the back of the crane. The water is forced through a valve and under the plunger of a cylinder between the uprights of the jib, giving a very smooth and even lift.

The Pedrick & Ayer Co.

Hand traveling cranes have undergone less change than the power travelers, although the details of design have been somewhat improved, and different hoisting devices have been substituted for the heavy trolleys and winches which were used in the earlier styles.

The jib crane has changed only in minor details of design, and, with one or two exceptions, remains as it was twenty-five years ago.

The locomotive crane is made much heavier and more durable,



TYPES OF PNEUMATIC HOISTS FOR SHOP, FOUNDRY, AND GENERAL USE.

On the lett, the regular pneumatic-motor wire-rope hoist made by the General Pneumatic Tool Co., Montour Falls, N. Y.; in the center, the pneumatic geared hoist of the Chicago Pneumatic Tool Co.; on the right, a pneumatic chain hoist made in sizes from 1 to 10 tons by the Dake Engine Co., Grand Haven, Mich.

and is designed for both steam and electricity, but since 1889-90 very few radical changes have been made in the general design of the steam locomotive crane. The application, however, of electricity as a motive power, has necessitated a locomotive crane of special design.

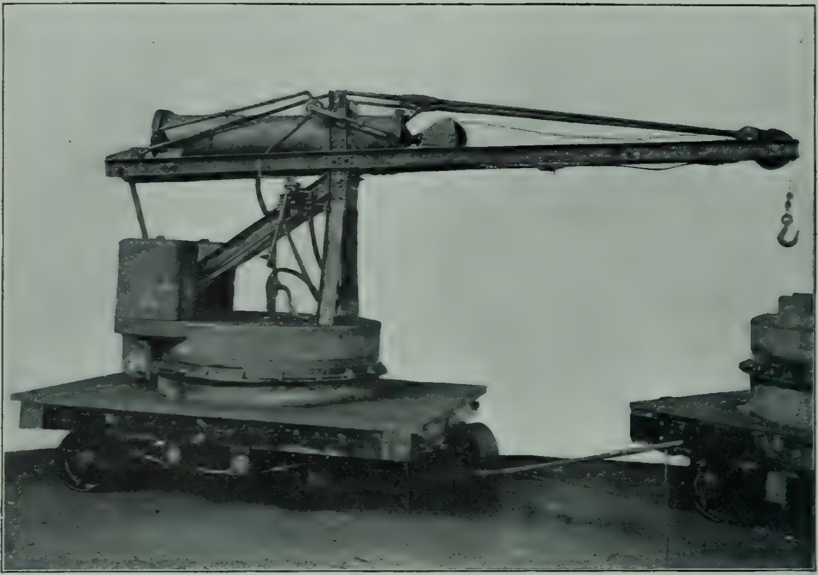
Chain Hoists.—The earliest and simplest form of chain hoist is known as the "Weston Differential Block," and was invented in the later fifties, reaching its final stage of perfection about 1864. A few years later the screw hoist appeared as a very formidable and successful competitor.

It was not until 1887-89 that the losses by friction in the differential and screw hoist were fully realized, when, at that time, Mr. Thomas A. Weston, working under the direction of Mr. Henry R. Towne, and assisted by the writer, developed the spur-gear hoist, which is known today the world over as the "Triplex Hoist." Its efficiency exceeds the differential and screw hoist about 250 per cent., the former having 80 per cent. where the two latter average about 30 per cent. In other words, the spur-gear type of hoist is over two and one-half times as efficient as any form of differential or screw hoist. Since that time, numerous forms of spur-gear hoists have appeared, both in England and the United States, all of them, however, adopting the same principle for sustaining the load. The action of any of these hoists depends entirely upon the quality of workmanship and the degree of nicety with which the lowering device is designed and made and its chains are fitted. Since 1890, there has been very little change in the general design of spur-geared types of hoists, and it has been the aim of the manufacturers to improve the quality of materials, workmanship, smoothness of action, durability, and strength.

Electric Hoists.—With the advent and perfection of the electric motor and its application to hoisting apparatus, the demand for a light, high-speed hoist has been growing, until, within the last four years, several forms of electric hoists have been placed on the market. Some of these are shown on pages 501, 510, 511, and 512.

Air Hoists.—The air hoist has been developed along the lines which the market has demanded, but except in foundry work, to which it is peculiarly adapted, it is not generally as popular as the electric hoist. It is used in the plunger and motor form, in places where electricity is not obtainable, or where the work requiring the use of the hoist will not warrant the expense of an electric installation.

The single-lift pneumatic cylinder hoist finds special application to work requiring smoothness of motion and freedom from jar, and



A PORTABLE PNEUMATIC JIB CRANE, 1,000-POUND CAPACITY, 7-FEET REACH.
Garry Iron & Steel Co., Cleveland, Ohio.

not requiring great exactness of range in the vertical lift. In spite of the low efficiency and inconvenience of the air motor, it has found favor in many places. The development dates from 1889 to 1890.

Hydraulic Hoists.—The hydraulic hoist is the result of the demands for a hoist of this character for use in certain places where neither air nor electricity could be used to advantage. The reliability of this hoist, where water is not liable to freeze, is such as to make it very desirable for certain cases. For general work, however, it is not to be compared with the electric hoist. The hydraulic hoist has never gone beyond the cylindrical or plunger design, and its selection depends upon environments.

Types of Hoists and their Characteristics.—Hoisting-machinery may be divided into two general classes—cranes and chain hoists.

Cranes.—Cranes, as applied to modern machine-shop practice, may be concentrated into the following types:—

(a) Traveling cranes (hand or power) which are intended to cover any point in any given rectangular space.

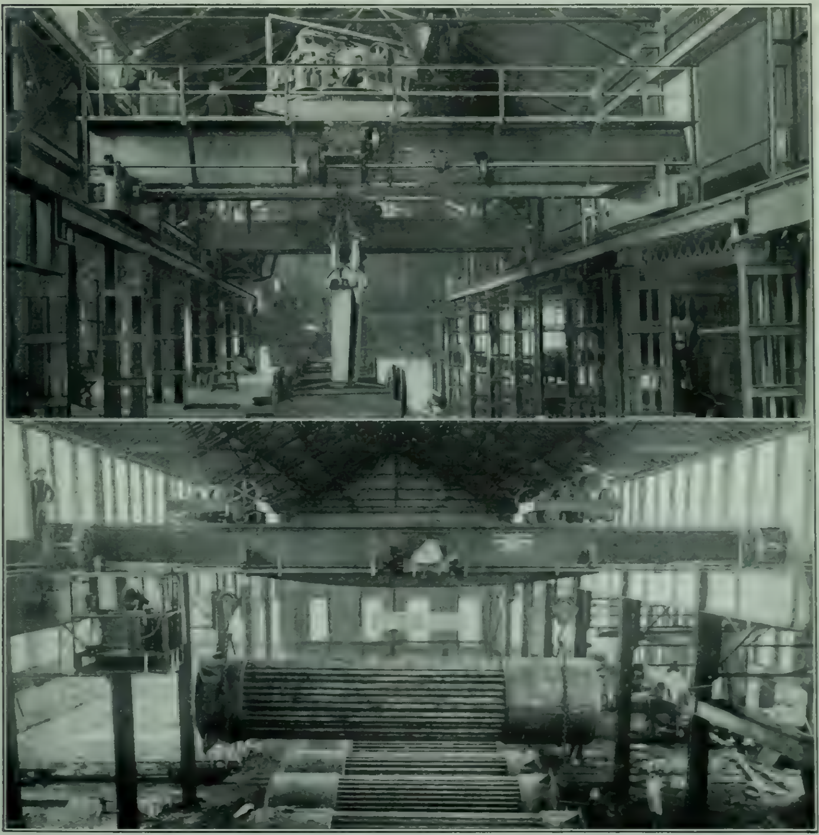
(b) Jib cranes (hand or power) which are intended to cover any point within the area of a given circle.

(c) Locomotive cranes (steam or electric) which are intended to cover given areas either side of a narrow or broad-gauge railroad track, in the machine shop or the factory yard.

The jib crane may be designed to perform the functions of the locomotive crane within a given area of the machine shop, but is not adapted for use where buildings do not give opportunity for supporting the top pintle.

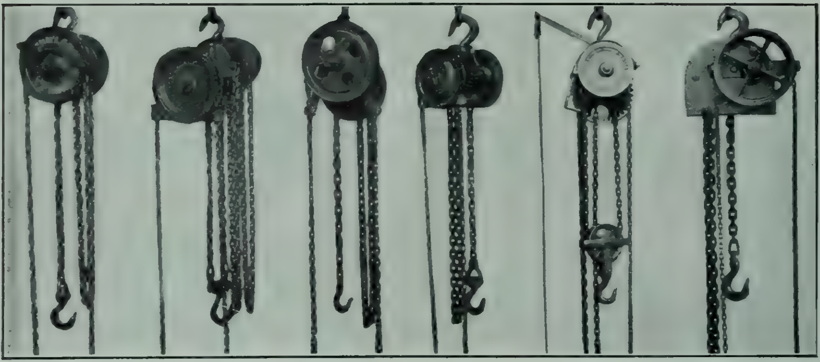
Chain Hoists.—The chain hoist is a portable machine which automatically sustains the load at any given point of its hoist and allows the load to be either lifted or lowered at the will of the operator, by pulling in one direction or the other on what is termed the "hand chain." It takes its name from the fact that the load is suspended on a chain passing over a pocket wheel, and the mechanism is also operated by a chain passing over a pocket wheel.

This type of hoist has grown from a luxury to a necessity in the modern machine shop, and is used exclusively in places that cannot



ELECTRIC OVERHEAD TRAVELING CRANES IN USE.

In the ingot crane, above, the hoisting mechanism is rotated on the trolley; Case Mfg. Co., Columbus, O. The crane below is double-trolley type, 50-ft. span, 35-ton capacity; Cleveland Crane Co., Wickliffe, O.

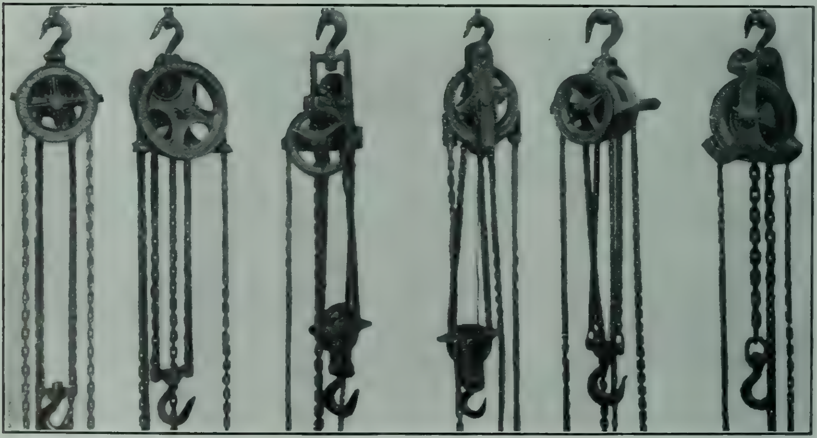


Triplex. Keystone. Facile. Speidel. Cherry. Victoria.

SPUR GEAR HOISTS.

The makers are:—Triplex, Yale & Towne Mfg. Co.; Keystone, E. Harrington, Son & Co.; Facile, Tangyes, Ltd.; Speidel, J. G. Speidel; Cherry, Tangyes, Ltd.; Victoria, unknown, but of English make.

be reached by the power traveling crane. In fact, so universal has its use become that a majority of hand travelers and jib cranes, of sizes from ½ ton to 20 tons, are equipped with this mechanism. It has many advantages over what is termed the "crab" and "winch" design of the earlier forms of hand travelers and jib cranes, inasmuch as the mechanism is self-contained and can be easily removed, in case of repair, and replaced by another; it is inexpensive, its cost of maintenance slight, and its efficiency is higher than it is possible to obtain by either the "crab" or "winch."



Duplex. Harrington. German. Acme. Moore. Boston & Lockport.

SCREW AND DIFFERENTIAL HOISTS.

Makers:—Duplex, Yale & Towne Mfg. Co.; Harrington, E. Harrington, Son & Co.; German, unknown; Acme, Franklin Moore Co.; Moore Anti-Friction, Chisholm & Moore; Boston & Lockport, Boston & Lockport Block Co.

SPEEDS OF HOISTING WITH VARIOUS TYPES OF HOISTS.

	SPUR-GEAR HOIST. Feet per Minute.				SCREW HOIST.		DIFFERENTIAL.	
Tons.	Full Load.	Half Load.	Quarter Load.	No. of Men.	Feet per Minute.	No. of Men.	Feet per Minute.	No. of Men.
¼	...	....	....	..	....	..	6.	1
½	8.	16.	24.	1	4.	1	6.	2
1	4.	8.	12.	1	2.	1	3.70	3
1½	4.8	9.6	14.4	2	2.40	2	2.50	3
2	3.6	7.2	10.8	2	1.80	2	2.30	4
3	2.3	4.6	6.9	2	1.10	2	2.30	7
3½	...	....	....	..	.95	2	....	..
4	1.7	3.5	5.2	2	.80	2	....	..
5	1.3	2.6	3.9	2	.65	2	....	..
6	1.1	2.2	3.3	2	.50	2	....	..
7	...	....	....	..	.40	2	....	..
8	.8	1.6	2.4	2	.35	2	....	..
10	.6	1.2	1.8	2	.30	2	....	..
12	1.1	2.2	3.3	4	....	..	....	..
16	.8	1.6	2.4	4	....	..	....	..
20	.6	1.2	1.8	4	....	..	....	..

	WEIGHT IN POUNDS. One man can hoist at 80 lb. hand-chain pull.			HAND-CHAIN PULL. In lbs. to lift full load.			FT. OF HAND CHAIN. To be operated to lift 1 foot.		
Capacity in Tons.	Spur Gear.	Screw Hoist.	Differential.	Spur Gear.	Screw Hoist.	Differential.	Spur Gear.	Screw Hoist.	Differential.
¼	....	....	500	...	...	72	...	...	18
½	1000	1000	600	62	68	122	21	40	24
1	2000	1700	800	82	87	216	31	59	30
1½	2300	2500	1000	110	94	246	35	80	36
2	2600	2700	1100	120	115	308	42	93	42
3	4000	3300	1000	114	132	557	69	126	38
3½	....	4000	....	...	140	...	...	138	..
4	5000	4600	....	124	142	...	84	155	..
5	6500	5300	....	110	145	...	126	195	..
6	7000	6500	....	130	145	...	120	252	..
7	....	7000	....	...	160	...	...	275	..
8	9000	7800	....	135	160	...	168	310	..
10	11000	10000	....	140	160	...	210	390	..
12	13000	....	....	260	...	...	126	...	..
16	17000	....	....	270	...	...	168	...	..
20	20000	....	....	280	...	...	210	...	..

The speeds are given for short lifts with men accustomed to the work; for continuous easy lifting, two-thirds of these speeds should be obtained. Quick and easy lifting comes from working the chain hand over hand, avoiding useless and fatiguing body motion. Many good workmen could save themselves much time and labor by observing this.

The Spur Gear Hoist lifts rapidly and the speed increases for light loads because the amount of hand-chain to be overhauled is small and the speed does not exceed that at which a man can move his arms.

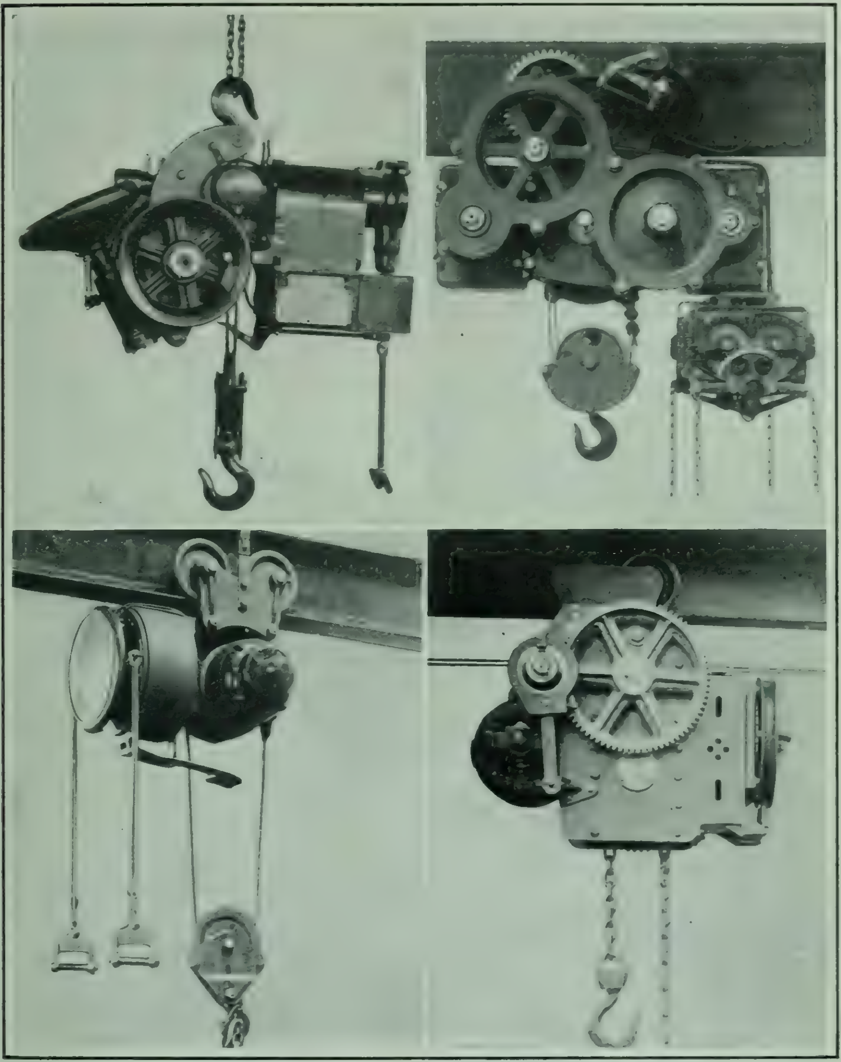
Selection of Hoisting Apparatus.—Volumes might be written on the selection of hoisting apparatus for the modern machine shop, with the probability that very few of the suggestions would be applicable to the case which an engineer might have in hand. The points which govern the selection of a hoist are varied in their make up, and depend largely on local requirements and conditions, and relation to the ultimate efficiency of the shop; so much so, that in the selection of any commercial type of hoist the immediate economy in labor-saving is so small, as compared with the commercial efficiency of the plant, that it could be almost ignored. In other words, the selection and installation of transportation facilities for the modern machine shop should always have a broad-gauge investigation and supervision, beyond the question of immediate economies in labor-saving. A few of the points, however, which may prove of value to those who anticipate the purchasing of hoisting apparatus are as follows:—

1.—The capacity for continuous operation.
2.—The character of the work on which the hoist is to be used.
3.—The frequency with which loads are to be lifted.
4.—The speeds best adapted for the work.
5.—The cost of maintenance.

At the present time, it is of paramount importance that the machinery of transportation in the modern machine shop shall be always ready to do its work. While mechanical efficiency, with minimum power consumption, is to be desired (where the cost of power is high), yet it is a secondary consideration as compared with the certainty of having the apparatus always ready for use. This is particularly applicable to high-class apparatus using either steam or electric power. On the chain hoist, however, where high-class labor is often called upon to remove work from the machines, the hoist of the highest mechanical efficiency and speed is not only desirable but imperative.

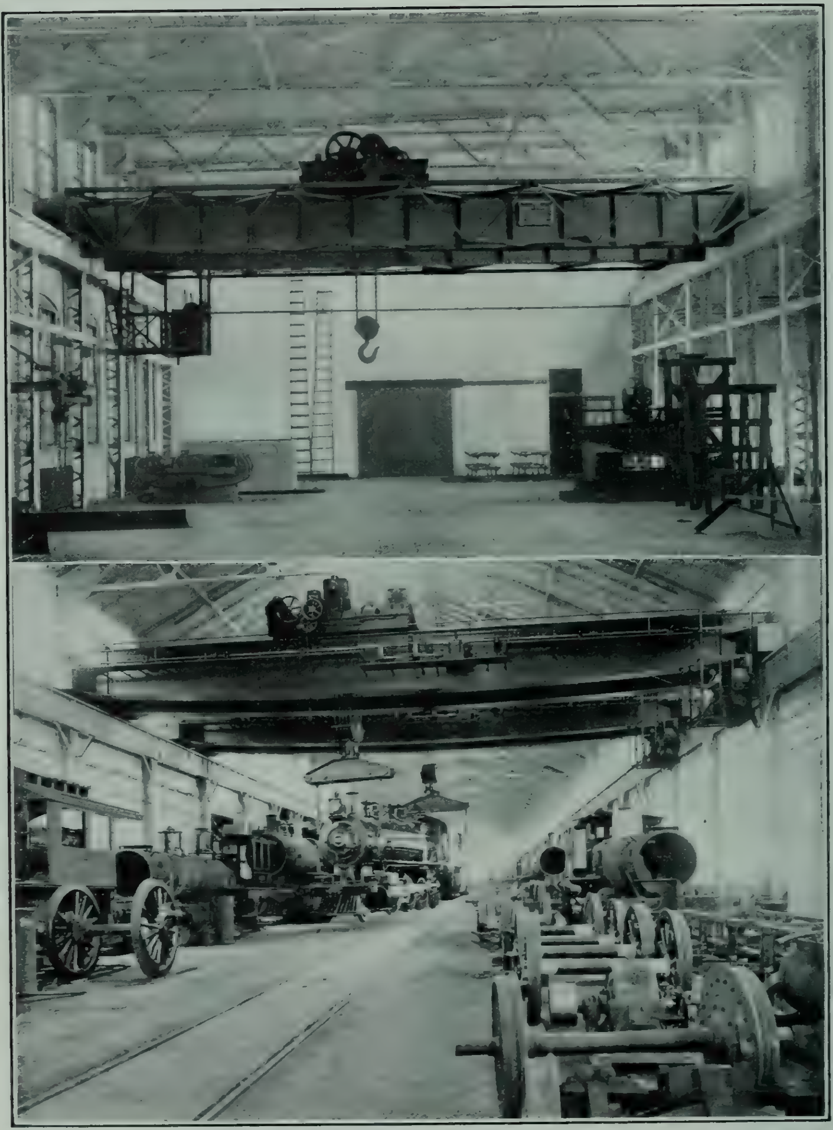
The characteristics of the work on which a hoist is to be used govern its selection more largely than any other one point. On this depends not only the first cost of the hoist, but also its life and commercial efficiency.

The number of lifts which a hoist is to make, per unit of time, is another important consideration. As an illustration:—A shop requires a 20-ton hoist, intending to lift a 20-ton load once or twice a month, while the average load lifted may be 10 tons lifted once or twice each day. It would be poor business judgment to select an expensive, high-speed, power hoist for work of this character. On the other hand, where a hoist is to lift its full capacity a number of times each hour, during the day, it is much better to install a hoist of 25 to 50 per cent.



A GROUP OF CHARACTERISTIC ELECTRIC HOISTS.
The upper figure on the left is a 2-ton hoist made by the Yale & Towne Co., Stamford, Conn.; immediately to the right of that is a 1600-lb. hoist, 8-ft. hook lift, by Pawling & Harnischfeger, Milwaukee, Wis.; the lower figure on the left is 1-ton hoist made by the General Pneumatic Tool Co. Montour Falls, N. Y.; that in the lower right-hand corner is by the Cleveland Crane & Car Co., Wickliffe, Ohio. The last three are of the electric trolley type.

greater capacity than is required, in order to insure against the element of wear and tear which must ultimately result from the continuous working of the mechanism to its full rated load, at too frequent intervals.



EXAMPLES OF MODERN ELECTRIC-CRANE INSTALLATION.

The upper figure shows a single trolley crane, using chain instead of wire rope for hoisting. The lattice girder form gives lateral stability with a minimum of material. Built by Brown Hoisting Machinery Co. The cranes in the locomotive works shown in the lower view may be used singly when the load admits, or doubly (as shown) for heavy loads. Wire ropes are used in the hoisting element. Span 76 ft. 4 in.; maximum hoist 75 tons, with auxiliaries of 10 tons each near the ends. Shaw Electric Crane Co., Muskegon, Mich.

Speeds of Hoists.—The speeds of a hoist should be carefully selected for the work it is intended to perform. For instance, a crane devoted to the handling of structural material in the yards or assembling shops can be speeded from 50 to 100 per cent. above the maximum hoisting speeds shown in Table No. 2. On the other hand, the foundry requires very slow, steady speeds in handling flasks and drawing patterns; while on the assembling-floors, and for placing materials on machines, a slow speed of hoist is also very desirable.

SPEEDS OF HOISTS.

Table No. 1. English Practice.

SPEEDS OF ELECTRIC OVERHEAD CRANES.

Speed, with full load, in feet per minute.

Lifting Capacity.	Hoisting.			Trolley Travel.	Bridge Travel.
	Main.		Auxiliary.		
Tons.	Ft.	In.	Feet.	Feet.	Feet.
100	3	6	14	50	80
100	2	0	7	50	60
50	6	0	24	70	125
50	3	0	30	40	80
40	3	0	..	50	80
20	10	0	40	100	200
10	10	0	..	60	150
5	20	0	..	60	150
3	30	0	..	60	150
3	30	0	..	100	325

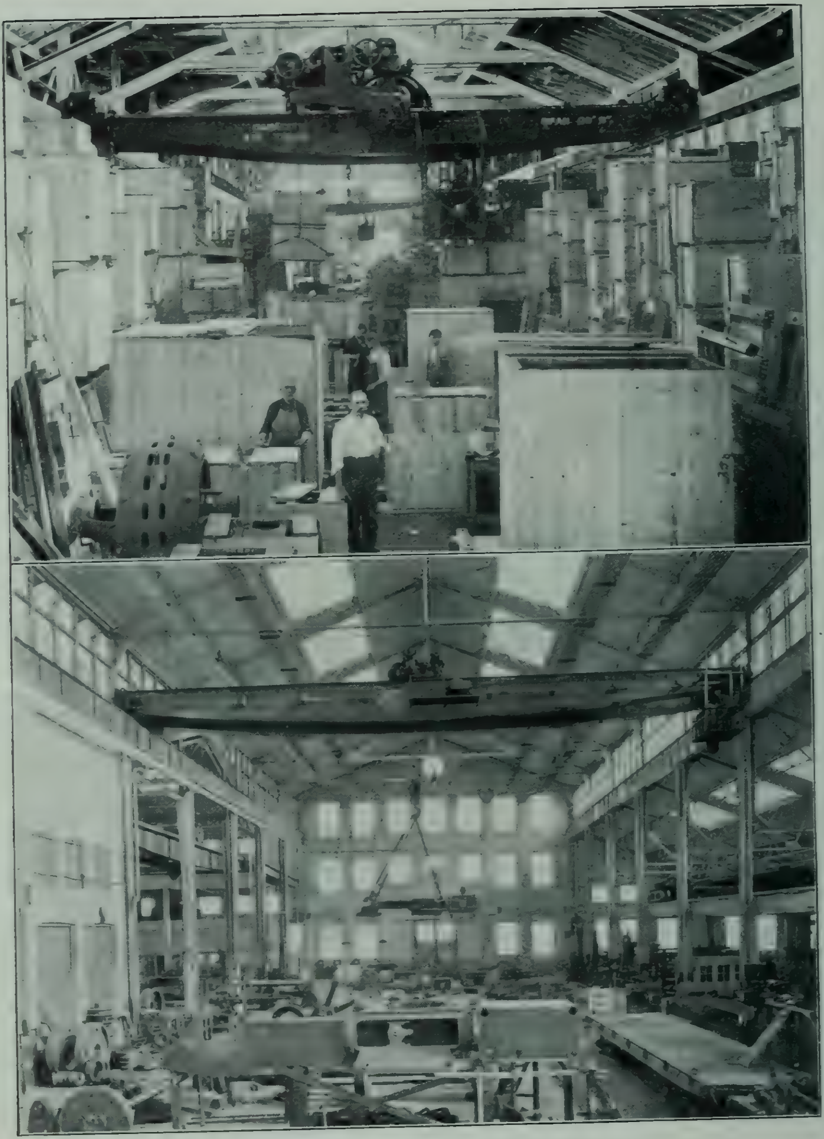
Iron Trade Review, August 17, 1904.

Table No. 2. American Practice.

Speeds all in feet per minute.

Capacity	Hoisting.		Trolley travel.		Bridge travel.	
Tons (2000 lbs.)	No load Max.	Full load Max.	No load	Full load Max.	No load	Full load Max.
5	40	20	125	100	325	250
10	60	24	125	100	325	250
15	28	14	125	100	325	250
20	30	15	125	100	325	250
25	30	12	125	100	325	250
30	20	10	110	90	325	250
40	16	8	110	90	250	200
50	25	10	125	80	300	250
75	18	7	100	80	250	200
100	25	10	125	100	250	200
125	25	10	125	100	250	200
150	18	7	100	80	250	200

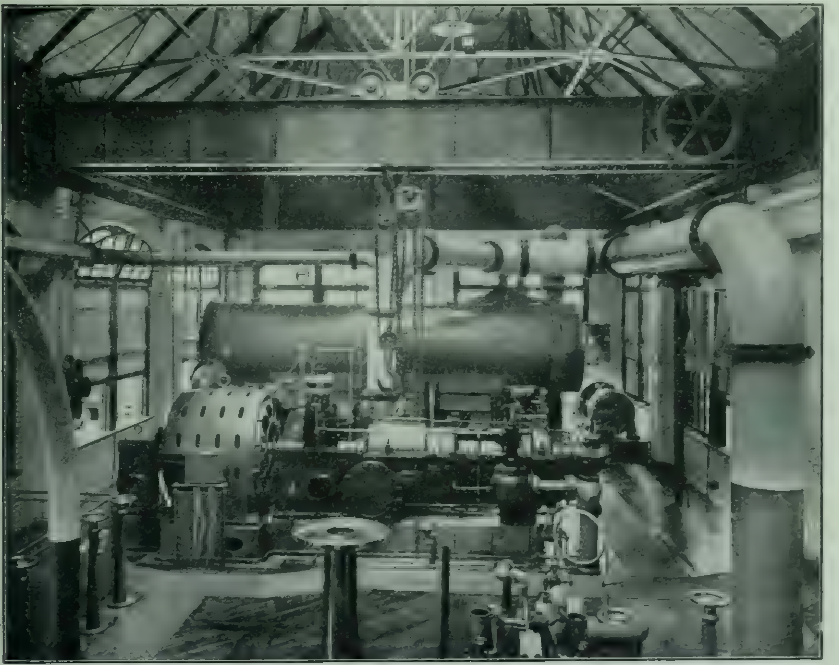
Note.—The apparent lack of uniformity in tabulated speeds in Table No. 2 is due to the fact that different firms build cranes within ranges of speeds and capacities, and differing sizes built by some are not built, or the speeds are not scheduled, by others. Cranes of 100 tons and above are all of the two-trolley type.



SHOP TRANSPORTATION BY OVERHEAD-CRANE SERVICE.

The upper picture shows the traveling crane applied to the service of the shipping floor, the installation being by the Morgan Engineering Co., Alliance, O., in the Schenectady works of the General Electric Co. The lower view is of a Pawling & Harnischfeger crane in the erecting shop of Nordberg Mfg. Co., Milwaukee; capacity 30 tons, with 5-ton auxiliary; span 80 ft., hook hoist 40 ft.; length of runway 190 ft.; speed of main hoist, 10 to 25 ft., of auxiliary 30 to 90 ft., of bridge travel 200 to 250 ft., and of trolley travel 100 to 150 ft. per minute.

Power Traveling Cranes.—This type of crane, as now manufactured, represents the culmination of energy and skill of the engineer. In the illustrations presented, it has been impossible, on account of the space available, to show all of the various types. Distinctive types, however, have been selected, and brief descriptions accompany each illustration.



A HAND TRAVELER OF 10-TONS CAPACITY IN THE POWER PLANT OF THE YALE & TOWNE CO.

The bridge is of ordinary form with truck ends and trolley traveling mechanism. A standard Yale & Towne triplex hoist is suspended from the trolley; the portability of the hoist permits its removal and use elsewhere in the works, in case of need.

Hand Traveling Cranes.—The hand traveling crane is particularly adapted to places where it is desired to cover a given area with a hoisting apparatus of minimum cost, such as store houses, power houses, assembling floors, and other places where frequent use and high speeds are not absolutely necesary. The only criticism that can be made of the hand traveling crane is that, on account of its low first cost, it is a great temptation to many manufacturers to install it where a power traveler would be much more economical in the long run.

Jib Cranes.—The jib crane can be utilized in almost any place where the building is sufficiently strong to withstand the resulting

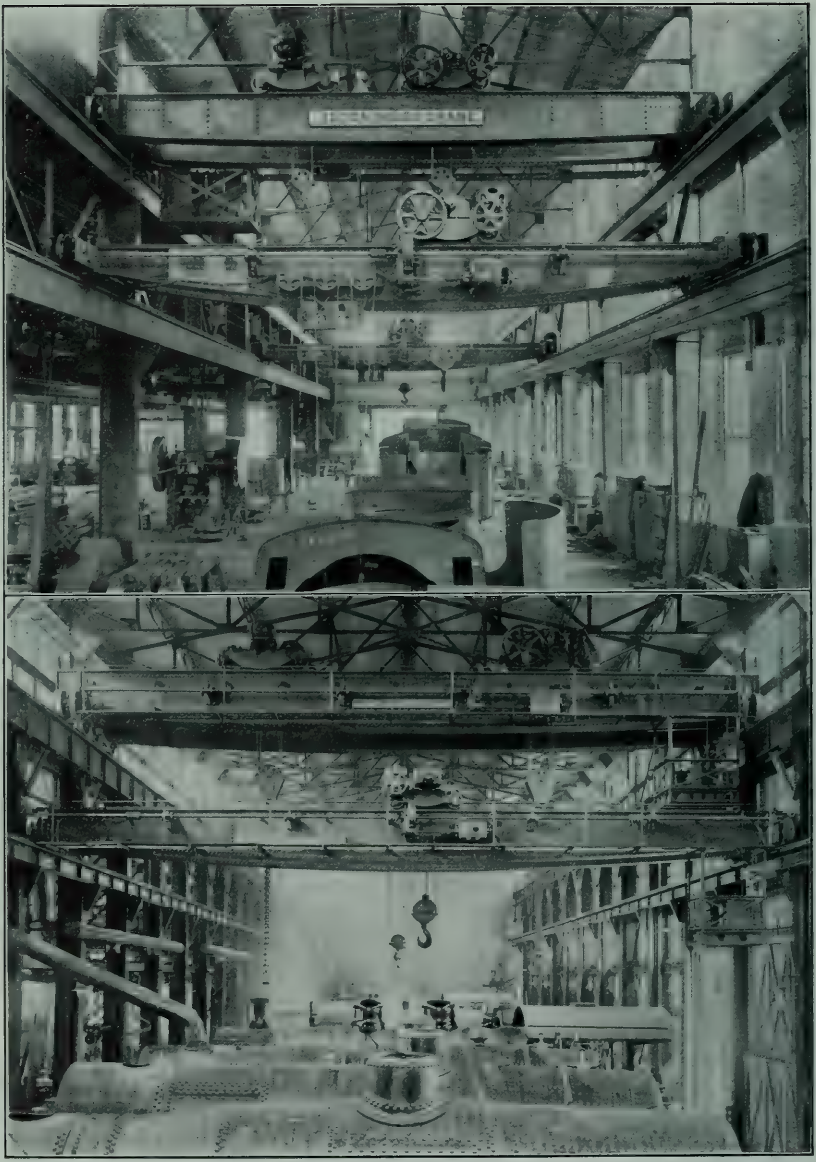
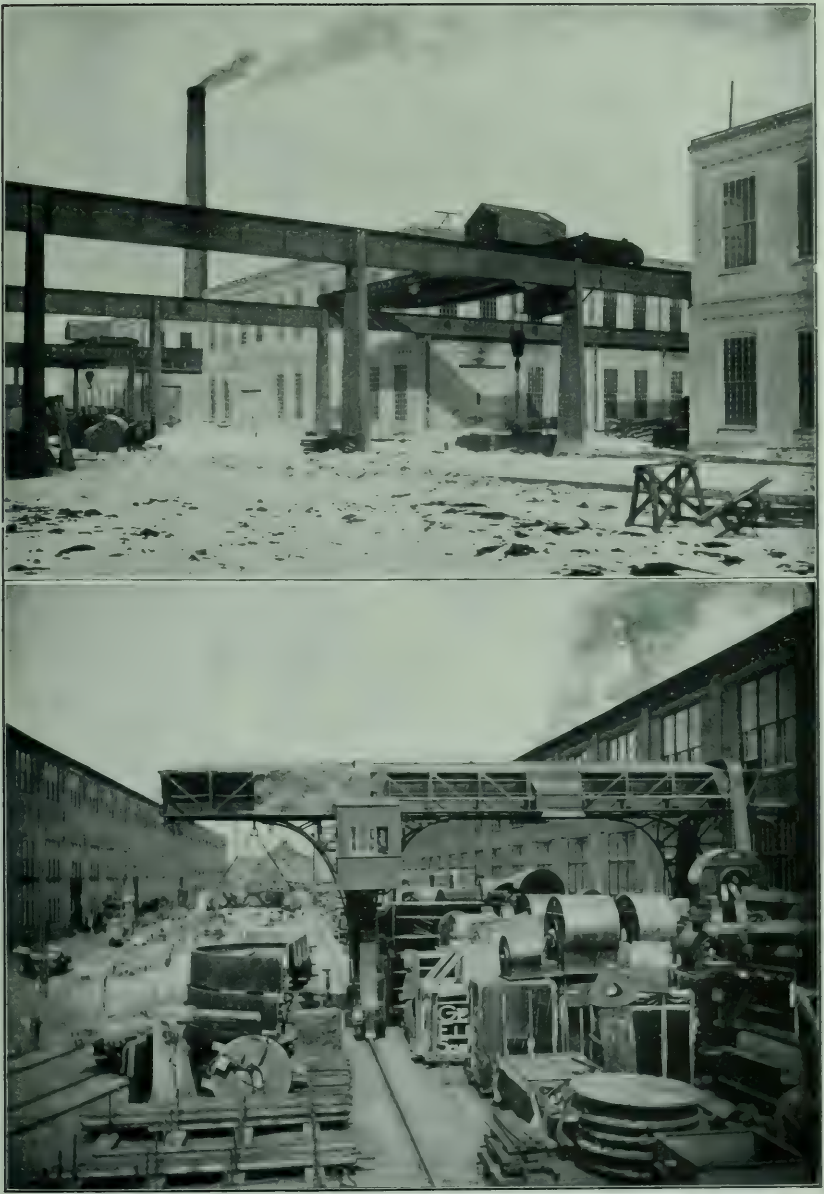


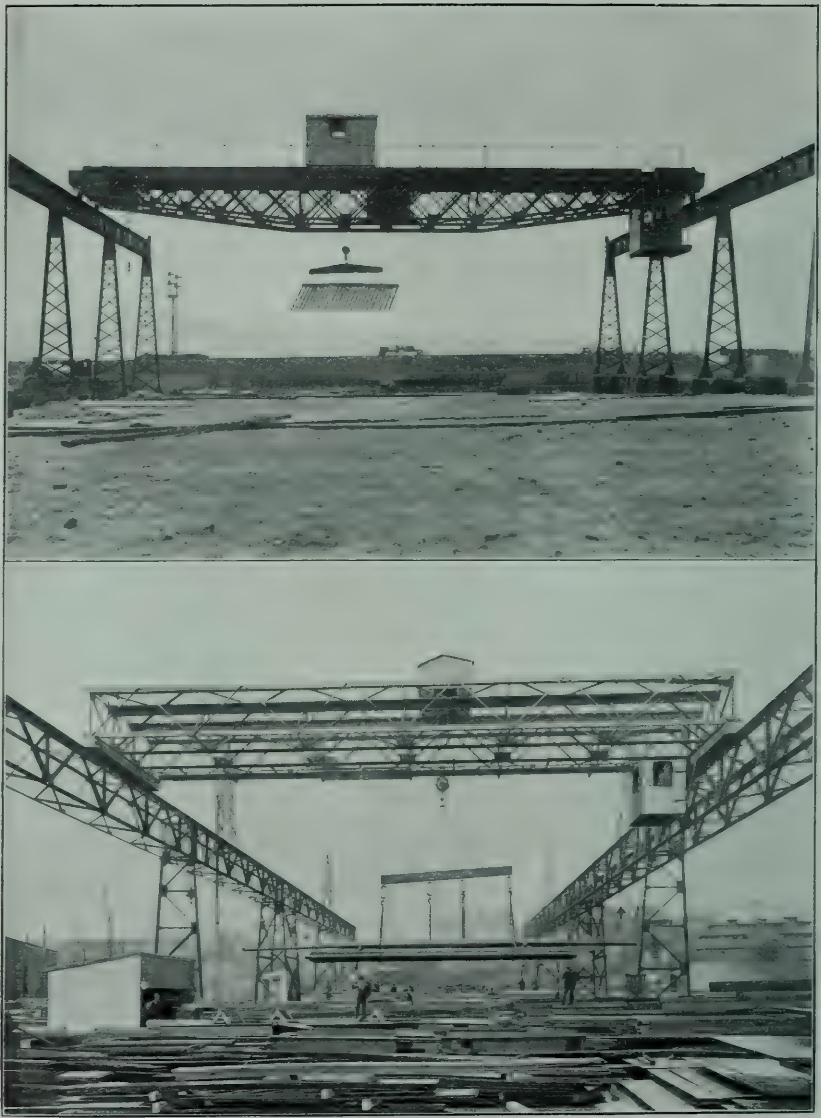
ILLUSTRATION OF THE "DOUBLE-DECK" METHOD OF UTILIZING TRAVELING CRANES.

Both are of Niles-Bement-Pond installation, the upper being in the Cooke Locomotive Works, and the lower in the Rogers Locomotive Works, Paterson, N. J. In the former there is one 10-ton crane with two 5-ton trolleys, and two 5-ton cranes—all of 30-ft. 8-in. span. In the latter there is one 100-ton crane with two 50-ton trolleys, and one 25-ton crane with 5-ton auxiliary; span 65 ft.



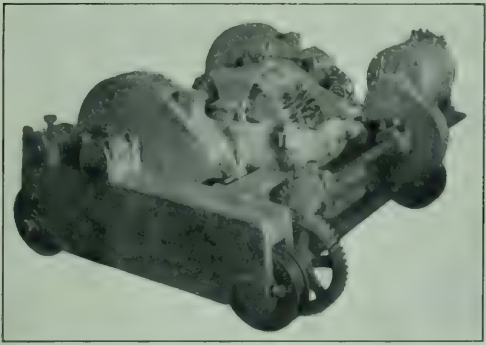
THE TRAVELING CRANE IN OUT-OF-DOORS SERVICE.

The lower illustration is taken from the Schenectady works of the General Electric Co. The combined gantry and cantilever shown in this figure is in use in the loading and shipping department. The two 40-ton overhead travelers in the upper picture are in service in the machine-shop yards of the Allis-Chalmers Co., West Allis works. They have a span of 67 ft., a hook lift of 22 ft., and a length of runway of 660 ft.; 220 volt, direct current.



OVERHEAD TRAVELING CRANES APPLIED TO OPEN-AIR TRANSPORT.

The upper view shows a 5-ton three-motor crane of 75-ft. span built for the Carnforth Hematite Iron Co., Ltd., by Thos. Broadbent & Sons, Ltd., Huddersfield; the speeds are, in feet per minute: hoisting, 60; longitudinal travel, 500; cross travel, 100. The lower view shows a 10-ton yard crane, 270-ft. span, installed by the Niles-Bement-Pond Co. for the Phoenixville Iron Co.; hoisting speed 20 to 40 ft., and travel 250 to 300 ft. per minute.



AN EXAMPLE OF ENCASED TROLLEY.

Applicable to situations where dust and dirt are likely to injuire the working parts. The trolley shown is for a 10-ton hoist; made by the Cleveland Crane & Car Co., Wickliffe, Ohio.

stresses due to the lifting of the required loads. It is especially desirable in the bays and side aisles of the machine shop of modern design, and can also be applied with advantage to the older design of shops, and give increased efficiency in the shop output.

Locomotive Cranes.—This form of crane has, to a large extent, become a necessity in all manufacturing establishments where extensive areas are to be covered in storage yards and shops. Some of the forms are shown on page 492. It will be noted in these forms of cranes that wire rope has entirely superseded the use of chain.

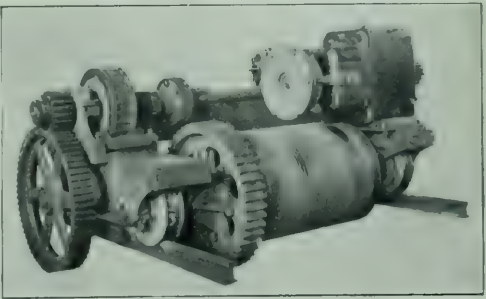
TABLE No. 3. AMERICAN PRACTICE.

LOCOMOTIVE CRANES.

Lifting Capacity. Tons.	Speed with full load in ft. per Minute. Hoisting.	Traveling.	Speed of Slowing. Complete Revolutions per Minute.
3	135	520	6
5	75	460	5
10	42½	500	4
20	25	300	2½

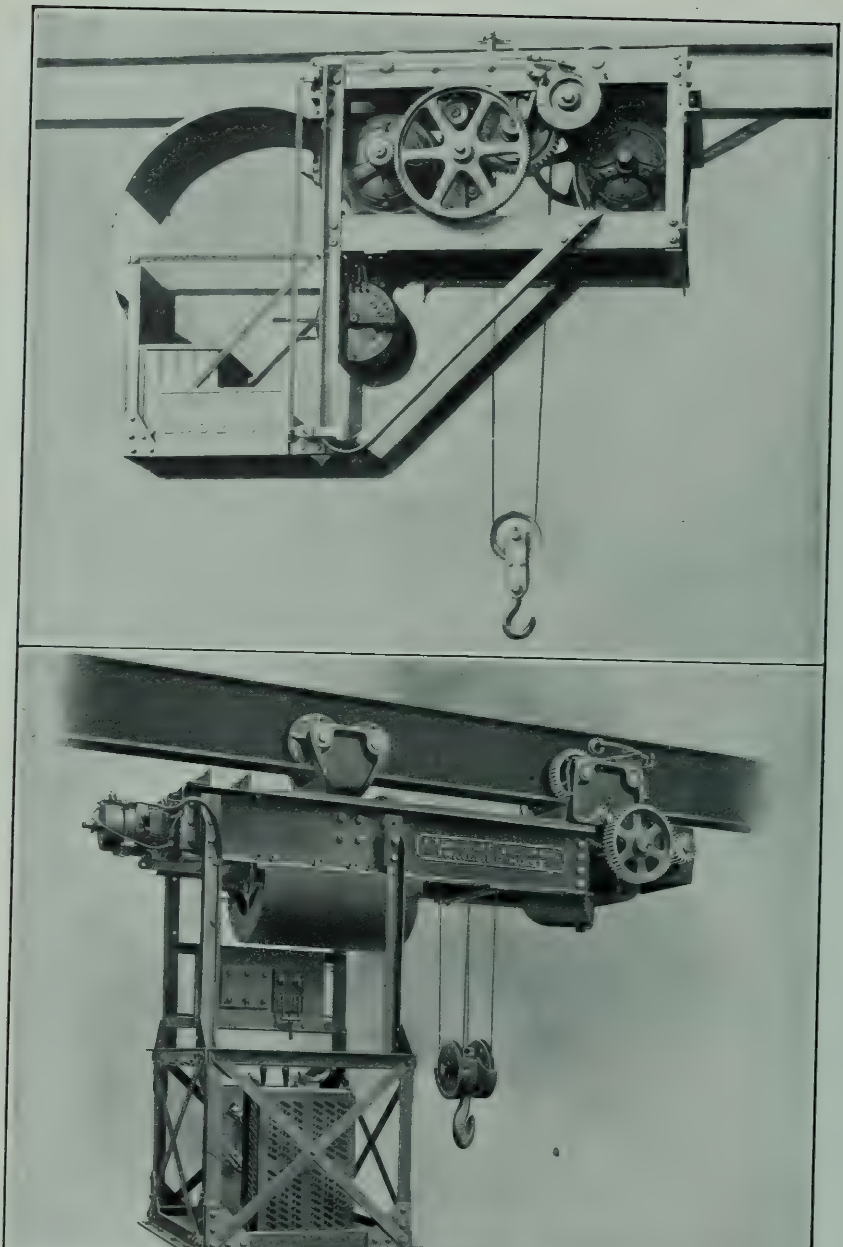
Iron Trade Review, August 27, 1903.

The economy of the locomotive crane depends largely on the crudeness with which materials have been handled before its installation. In some instances it has paid for itself in six months' time. Its minimum economy has been 10 per cent. net on the investment.



AN EXAMPLE OF NON-ENCLOSED TROLLEY.

For use with electric-power traveling crane. Made by the Case Mfg. Co., Columbus, Ohio.



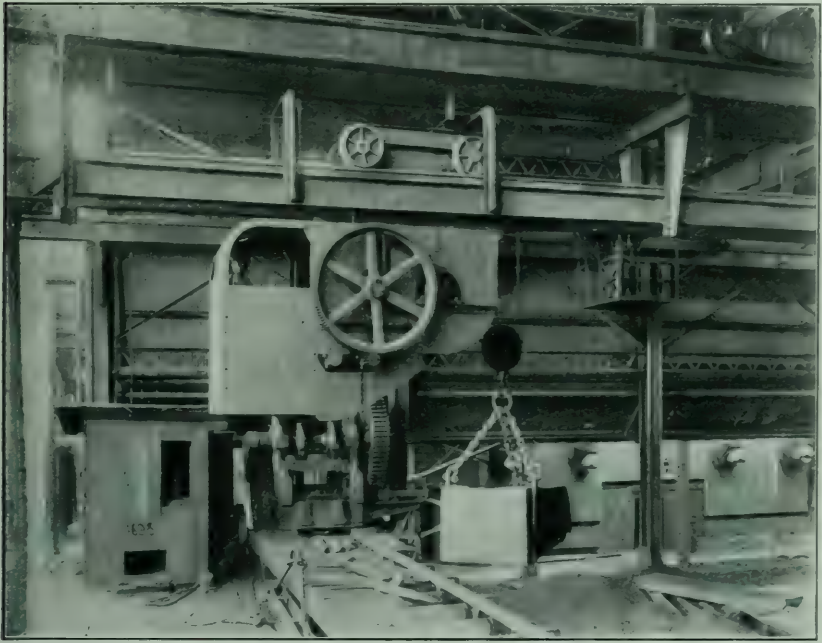
69

EXAMPLES OF TRAVELING HOISTS WITH TRAM-RAIL SUSPENSION.

In the upper picture is shown a 2-ton electric overhead traveling hoist supplied to Stewards & Lloyds, Ltd., by George Russell & Co., Ltd., Motherwell; in the lower one is seen a 3-ton electric traveling hoist made by the Niles-Bement-Pond Co.

Electric Hoists.—This form of hoist can be properly divided into two classes, the portable and non-portable, distinguished as follows:—

The portable hoist has a single hook suspension and can be readily transferred to any type of crane or trolley, or any form of support of sufficient strength to carry safely the load which it is intended to lift.

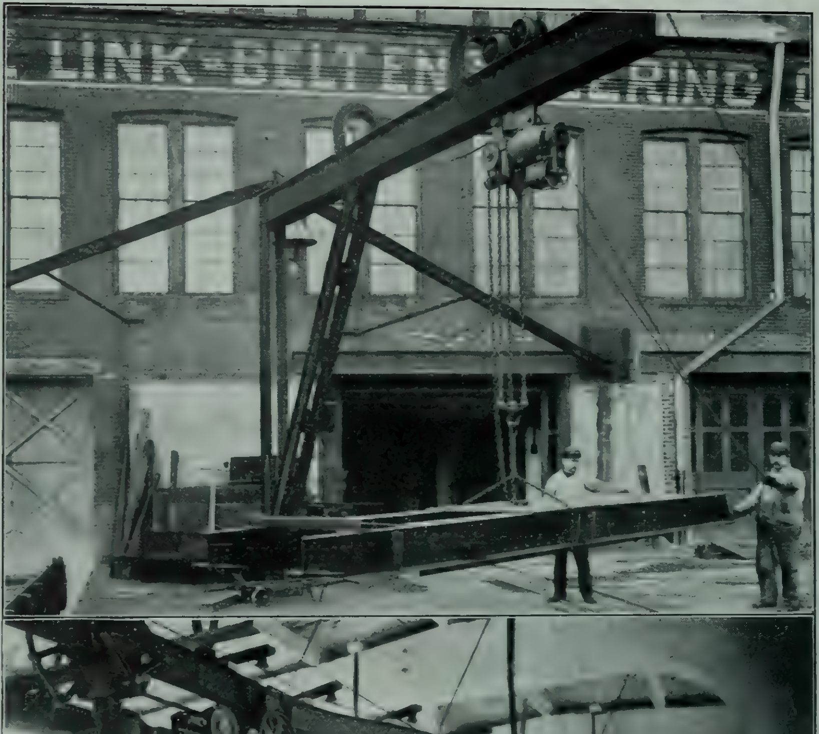


ELECTRIC HOIST AND CONVEYOR.

The Chamberlain patent, as installed by the Link Belt Engineering Co.; from 1 to 5-tons capacity, 40-ft. per minute hoisting speed and 600-ft. trolley speed.

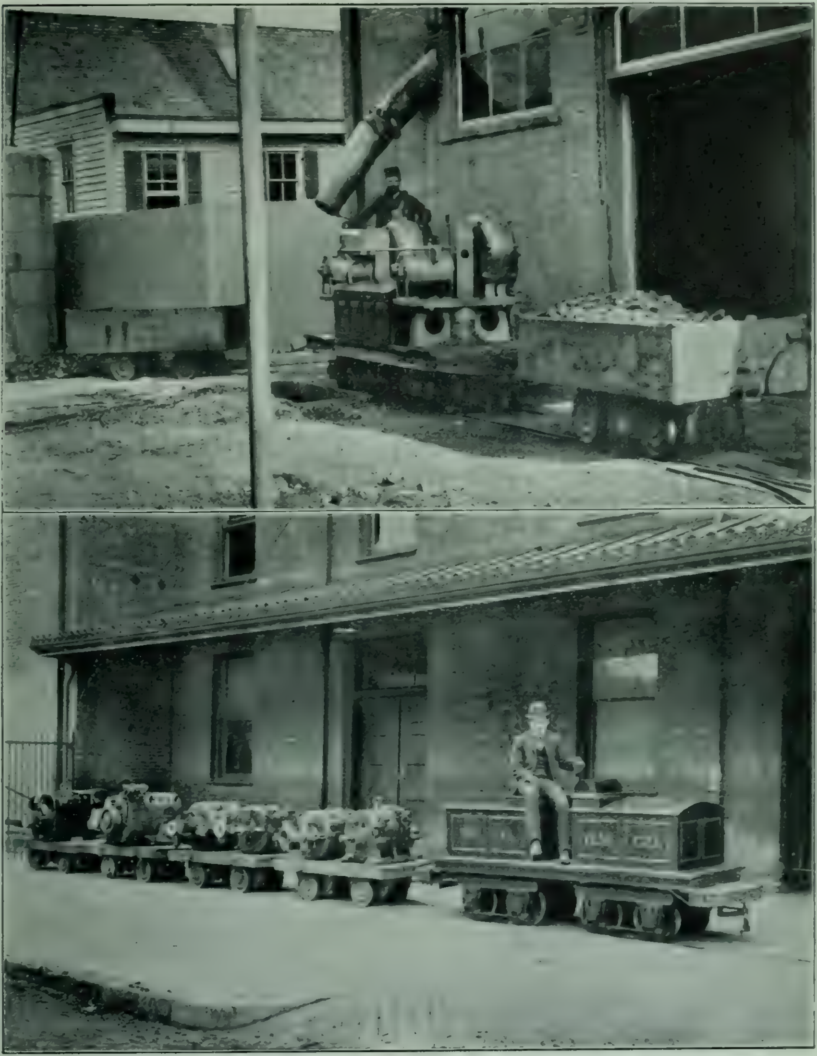
The non-portable form is built into the trolleys, designed to run on the I-beam or other form of tram rail. Of this latter type, three of the figures on page 501 show different forms of the non-portable hoist as operated from the floor. The figures on this page and the one facing show a type of hoist operated from a platform attached to the trolley, which has become very popular for certain classes of work. The portable form of hoist shown on page 501 can be readily taken from one place to another, as conditions may require.

Industrial Railroads.—Thus far, we have considered methods of transportation by which the article to be transported is carried to its destination while suspended in the air. The following illustrations show a slightly different method of obtaining results by the industrial railway, which may be either of narrow or broad-gauge construction.



INSTALLATIONS OF ELECTRIC TROLLEY HOISTS FOR FACTORY TRANSPORTATION.

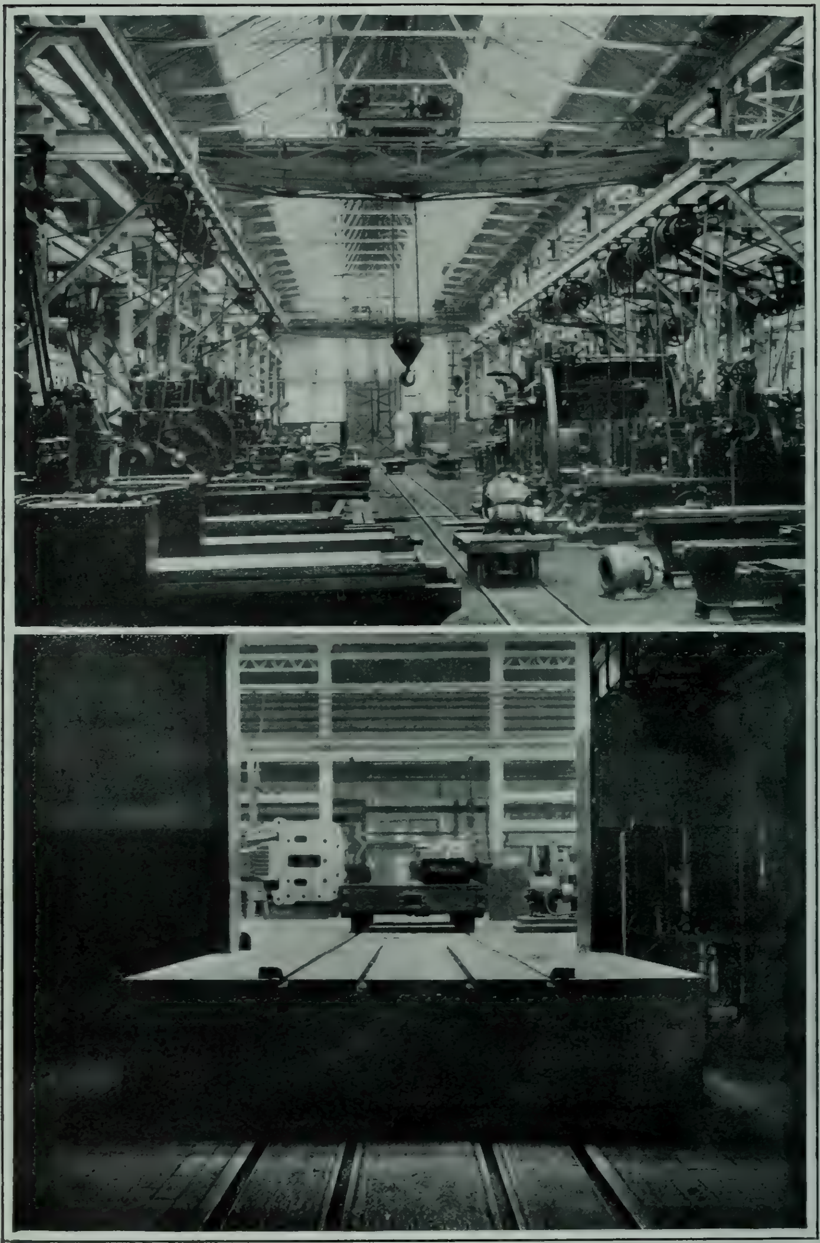
The upper figure shows a Sprague electric hoist mounted on a jib crane in the shops of the Link Belt Engineering Co., Nicetown, Phila.; the lower one shows a two-motor design of 1 to 3-ton capacity, 200 to 300 ft. per minute travel, using 220-volt direct current, made by the Northern Engineering Works, Detroit, Mich.



ELECTRIC LOCOMOTIVES FOR INTERNAL TRANSPORTATION IN THE WORKS.

The upper figure is a C. W. Hunt Co. electric storage-battery locomotive; the lower is a Westinghouse storage-battery locomotive in service in the shops of the Westinghouse E. & M. Co.

As the broad-gauge construction enters into the discussion of freight facilities and other matters which are necessarily outside of the category of machine-shop practice, the accompanying illustrations are intended to represent the typical narrow-gauge industrial system applied to shop work.



MACHINE-SHOP APPLICATIONS OF THE INDUSTRIAL RAILWAY.

The upper picture is taken in the works of the British Thomson-Houston Co., Rugby; the lower is in Westinghouse E. & M. Co.'s shops, and shows the industrial railway in the center of standard-gauge track, and the elevating table to equalize the difference in level of two floors. Both installations are by the C. W. Hunt Co.

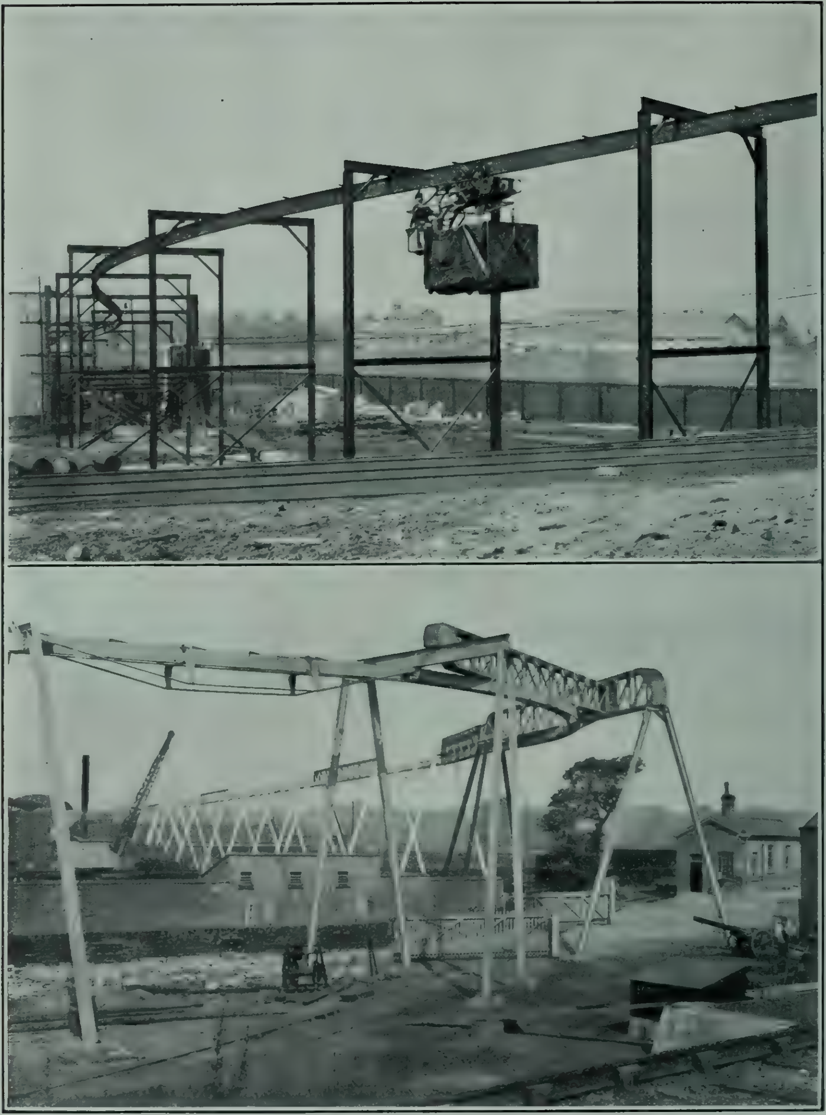
The economy of the narrow-gauge system depends largely upon the crudeness of the methods before employed. In numbers of cases, installations of this character have saved their cost in a year, and, when installed with proper judgment, the industrial railway will undoubtedly pay high interest on the investment.

THE TROLLEY TRACK IN SHOP TRANSPORT.
Coburn Trolley Track Mfg. Co., Holyoke, Mass.

Cost of Maintenance.—It has been impossible to obtain reliable figures as to the actual cost of maintenance of the apparatus which this article describes. Every modern machine shop, however, is equipped, more or less, with cranes and hoists, and the cost of maintenance and repairs must necessarily be very moderate as compared with the results secured. The parts which require most frequent renewals on the modern traveling crane are the axle bearings for truck wheels on the bridge and trolley, brushes, and contact fingers in the controller. Where chains are used for hoisting, the removal and annealing of the chains, with an occasional replacement, are required. Where wire ropes are used as the hoisting element, the renewals of the wire rope (at a comparatively small expense) are all that is required.

On chain hoists that are used frequently (where the chain passes over the pocket wheels) it is necessary to renew the chain occasionally, as the wear of both the wheel and the chain will, in time, prevent their working together properly. Replacements from other causes than the above are traceable either to negligence or careless handling on the part of the employee, or to deliberate overloading or abusing of the apparatus beyond its rated capacity.

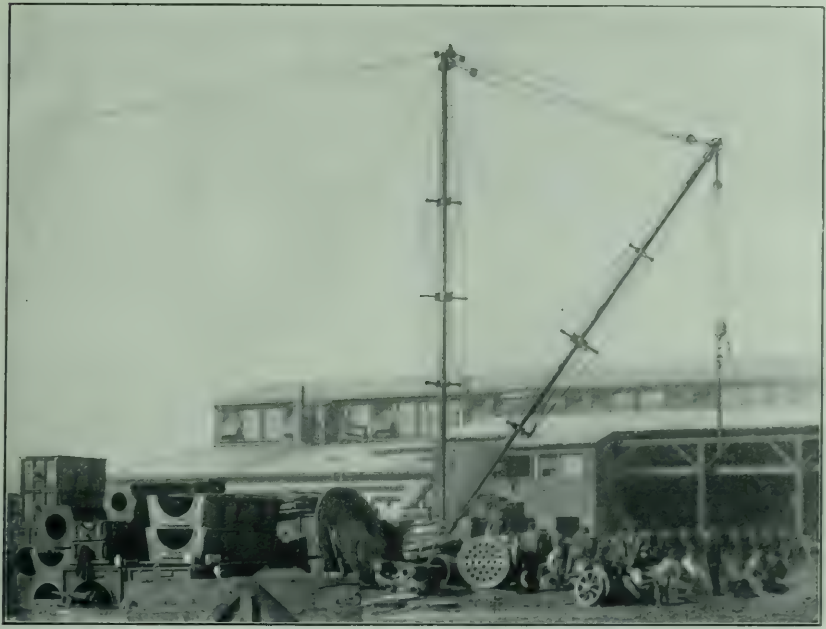
Overloading from careless and improper handling can, to a great extent, be prevented by systematic and careful instructions in the



TWO CHARACTERISTIC EXAMPLES OF MECHANICAL HANDLING BY THE USE OF TRANSPORTERS.

The upper picture shows a Temperley "electric traveling crab" transporter, 1½ to 3-tons load, 80-ft. per minute lift, 800-ft. per minute travel, carrying material from wharf to factory, up a grade of 1 in 13, at the British Fire Lighters Company's works. The lower view shows a transporter built by and used in the works of Andrew Handyside & Co., Ltd., for conveying material between machine shop, rivetting sheds, and erecting shop; it is electrically driven and will carry a load of 10 tons.

method of handling machinery of transportation, and where the number of machines is large and their character varied, the same attention should be given it as to the power equipment of a plant. This system is carried out to quite an extent in the largest and most progressive shops of the day, and applies equally well to a shop with only one small hoist.



THE DERRICK-CRANE ADAPTED TO HANDLING MATERIALS IN THE YARD.

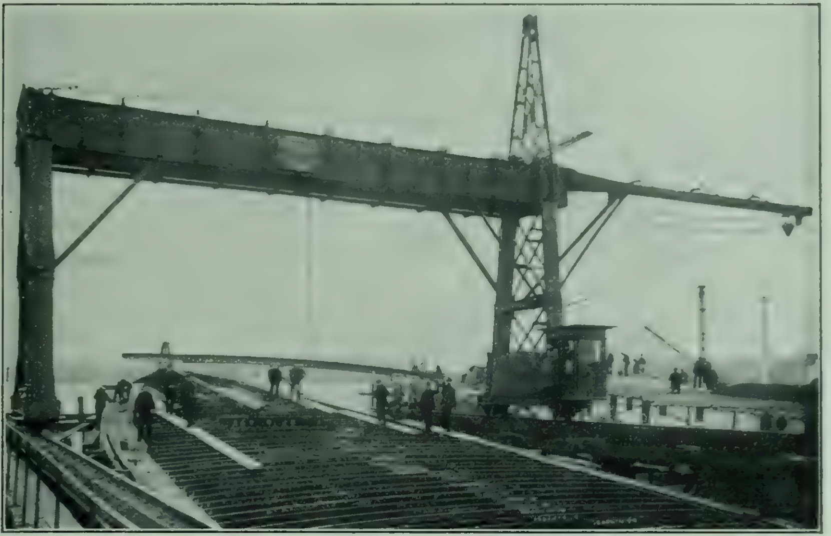
Ten-ton capacity wrought-iron tubular derrick, 55-ft. mast and 50-ft. boom, plant of Henry R. Worthington. Built by American Hoist & Derrick Co., St. Paul, Minn.

Care and Inspection.—In order to insure against accident, or against appliances being out of commission, systematic inspections should be made on all hoisting apparatus, from the largest and most expensive to the smallest and least expensive—not only because all machinery should be kept in first-class condition, but because of the damage which is liable to occur to life, limb, or property when apparatus is allowed to wear to a point where it will break down. Inspection is especially desirable in the lighter forms of chain hoists, as it is quite frequently the case that, through poor judgment or carelessness on the part of the employee, a hoist is broken and the fact is not properly reported. The next time it is used, some one is seriously hurt or very much frightened, and the number of miraculous escapes from injury to employees and machinery is surprising in shops where no method of care and inspection has been systematically followed. The principal cases of weakness in an average hoist are generally produced by overstraining at some time, from intentional overloading or from careless handling or abuse on the part of the operator; while inspection will not eliminate this, it will prevent it, many times, before damage has been done.

Commercial Efficiency.—The ultimate value of any shop appliance is its commercial efficiency. By this is meant its participating value in increasing the annual production. The correlations of the productive, non-productive, and contributive elements of the manufacturing plant are becoming so interwoven that it is very difficult, at times, to draw the line between them. In fact, all of the above are the producing elements of a manufacturing organization. It will thus be seen that it would be absurd to attempt to place any definite figures to the credit of the machinery of transportation, as it is so closely allied with the machine tools, the buildings, and the motive power of an establishment, that it can be truthfully said that no shop is complete without them all. It should, therefore, be borne in mind that, whenever a crane or chain hoist is intelligently placed in a position which facilitates the handling of a product, though it may be difficult to see the direct return, it can be assured as a general proposition that it will be a contributor in a greater or less degree toward raising the commercial efficiency of any plant.

Effect on Shop Costs.—With modern methods of production, the elimination of unnecessary delays, etc., is necessary to the last degree. With rapid-production methods on either the premium, bonus, or piece-rate plan, it is absolutely necessary to reduce the element of unforeseen contingencies to a minimum. This necessitates the prompt and immediate serving of every employee, which cannot de done except by systematic and proper study of the transportation problem. Each machine should have its work promptly removed and other work ready to take its place, and the less delay occurring between these changes, the more accurate becomes the record of shop costs.

The amount of fixed charges in the shop of today, and the cost of maintaining the commercial organization, combined with the cost of buildings, equipment, and manufacturing organization, is such that the direct saving in labor cost of handling materials is lost sight of in the increased output of the plant as a whole. This is the most logical view to take on the question of installing appliances for handling materials in the machine shop, and, if systematically planned and car-

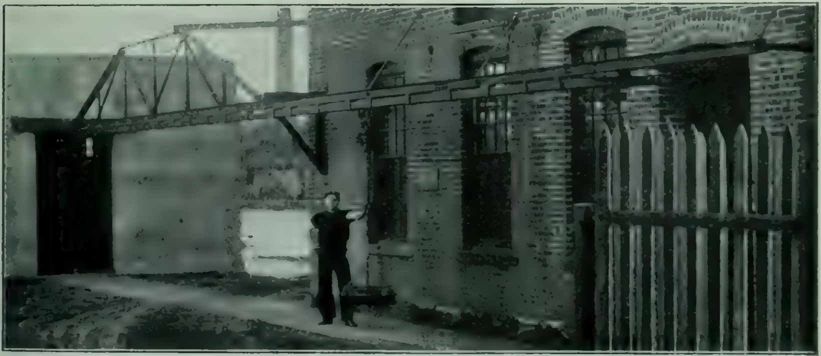


5-TON TRAVELING GANTRY CRANE, HARLAN & HOLLINGSWORTH SHIPYARD, WILMINGTON, DEL.

Bridge 70 ft. above ground and 51-ft. span; driven by three variable-speed motors; Wm. Sellers & Co., Inc., Philadelphia, Pa.

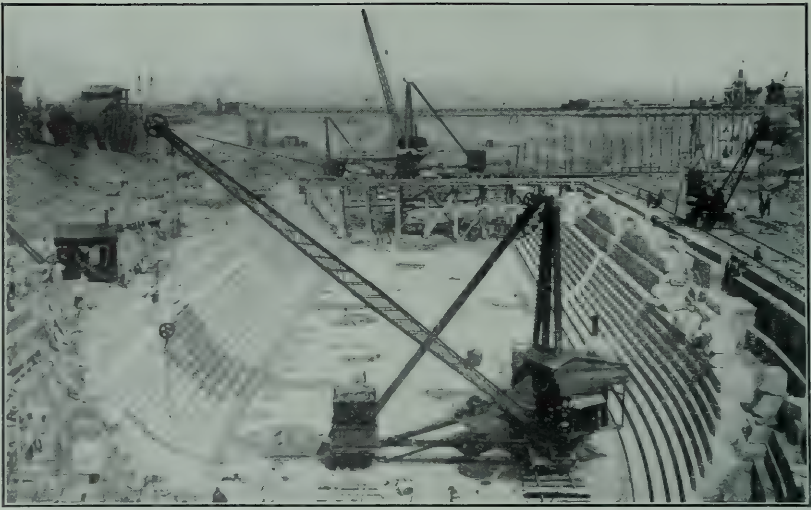
ried out, its results will more than satisfy the most sanguine expectations.

In conclusion, the field of mechanical transportation is broader than ever, and should receive detailed study and systematic investigation in whatever place it is to be carried out. It will not do to hang a hoist here and there, at random, and expect to get the best results. The entire problem should be considered as a whole, with the idea that each piece of apparatus installed is a part which goes to make up the grand total of maximum efficiency in the machine-shop output.



OVERHEAD TROLLEY TRACK INSTALLED FOR INTER-COMMUNICATION BETWEEN VARIOUS PARTS OF THE WORKS.

Coburn Trolley Track Mfg. Co., Holyoke, Mass.



Portable cranes and contractors' machinery at work at Gibraltar. John M. Henderson & Co.

EXCAVATING AND CONVEYING MACHINERY IN CONTRACT WORK.

By C. H. Wright.

Mr. Waldron's article dealt with apparatus directly serving the needs of the builder of machinery. Mr. Wright, with like authority born of intimate association with his subject, takes up the devices suited to the work of the constructing civil engineer.—The Editors.

IT is not very many years ago that twenty-five miles an hour was considered satisfactory speed for express trains. Today passengers grumble at the slowness of trains running from fifty-five to sixty miles an hour. Mountains are tunneled and hills leveled down, that a saving of a few miles in distance and a few minutes in time may be effected.

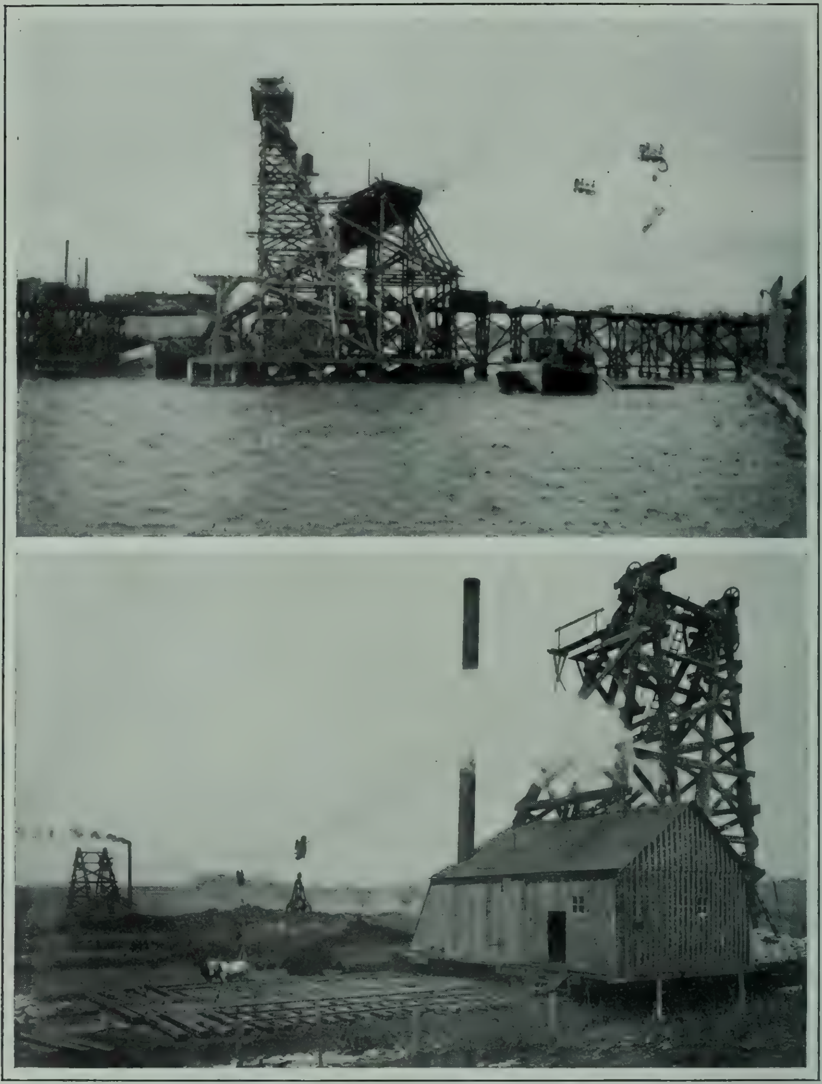
Formerly, if a railroad embankment was to be made, a small army of laborers would be sent to a gravel bank, and the material would be shoveled onto cars and then shoveled off again at the point where the fill was to be made. Today, huge steam shovels and a half-dozen men will load a train of cars in a few moments, and then scrapers operated by machinery, controlled by one or two men, will scrape the material from the cars and dump it in piles along the sides of the track at the point where the new fill is to be made, in even less time than was consumed in loading it. Mechanical spreaders, running on the railroad tracks, then come along and spread the material evenly and to any desired depth, over the top and sides of the new embankment. Drainage ditches along the sides of the track are dug and kept in proper condition by ditching machines, which not only remove the material but load it on cars ready to be hauled away.

Railroad bridges of moderate span are built and riveted up complete at the shops, and are then unloaded from the cars by derrick cranes mounted on flat cars, which land the new bridge along the side of the tracks adjacent to its final location, or often place it directly in its permanent and final position on the masonry abutments.

The engineering papers are full of the descriptions of great undertakings, such as tunnels, subways, canals, harbor improvements, and great buildings, many of which would be impracticable or even impossible without the aid of the most perfect machinery and appliances for the rapid, economical, and safe handling of large quantities of material.

Labor-saving appliances are replacing laborers by the thousands; and yet this does not mean, as is being asserted by some, that laborers are being deprived of their means of livelihood. It is capable of demonstration that where one laborer has been deprived of employment by modern machinery, opportunities have been furnished for a half-dozen to obtain more congenial and lucrative employment. If a fifteen or twenty-story building is being constructed, the old methods of conveying brick and mortar on the backs of laborers, who climb on ladders from floor to floor, would be both too slow and too expensive. Elevators moving with speeds of two hundred to three hundred feet per minute now carry this material from floor to floor, and steel beams and columns weighing tons are safely hoisted one hundred feet in the air, and placed in position in a very few minutes, with perfect safety to the half-dozen men who need be employed.

The handling and moving of large quantities of heavy and bulky materials has proved an attractive field for engineers and contractors. This branch of engineering has become almost a separate and distinct line of industry, and has attracted some of the keenest, most able, and perhaps boldest minds in the engineering profession. The results which they have accomplished in this field easily place their work in the front rank, not only of engineering, but also of executive and industrial achievements. The diversity and magnitude of engineering works, which are being carried on by labor-saving machines and appliances, can perhaps best be illustrated by a few examples.



APPLICATIONS OF THE CABLEWAY TO ENGINEERING CONSTRUCTION.

The upper figure shows Temperley transporters applied to submarine work. The lower one shows a Lidgerwood cableway, 625 ft. span, 1½ yd. orange-peel bucket, 57 ft. traveling towers, at work on the Illinois & Mississippi Canal.

Cableways.—There are many locations where cableways furnish a convenient and economical method of handling materials. Notably has their use been successful in the construction of large dams, built of earthwork and masonry. Where the dam is built between high steep slopes, suitable anchorage for the main cable can be economically provided, and it is not necessary to build high and expensive towers to provide sufficient sag for the cable.

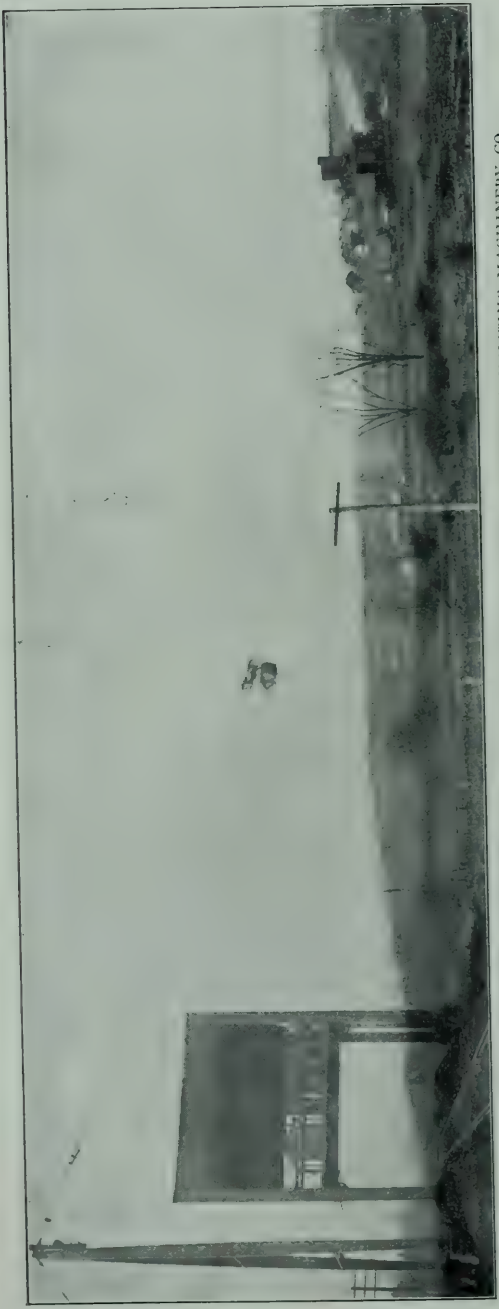
Spans of 1,200 or 1,500 feet are common. A span of 1,350 feet was used in the construction of the dam at Austin, Texas; and with it, loads of 7 or 8 tons were conveyed at a speed of 700 to 800 feet per minute. In spans of this length, some provision must be made for holding up the lines which are used for racking the trolley and hoisting the loads; otherwise the deflection of these ropes would be so great, as to cause trouble in lowering the empty hook or bucket, and possibly in lowering light loads. Many different devices have been used for supporting these ropes. One of the simplest and most effective, perhaps, is that used by the Lidgerwood Company. An auxiliary rope, called the button rope, is suspended just above the main cable, and attached to this rope at various intervals are knobs or buttons. The sag carriers, which run over this rope, are provided with openings of various sizes. As the trolley travels along, it will pick up these sag carriers, one by one, and carry them along to the end of the run. There is a small horn or projection in front of the trolley, for picking up and supporting the carriers. When the trolley moves in the opposite direction, the carriers are dropped one by one, and distributed along the length of the rope, which is thus supported at proper intervals. From 400 to 500 cubic yards of earth or broken

WARSHIP TAKING COAL FROM A COLLIER BY THE MILLER-LIDGERWOOD MARINE CABLEWAY.

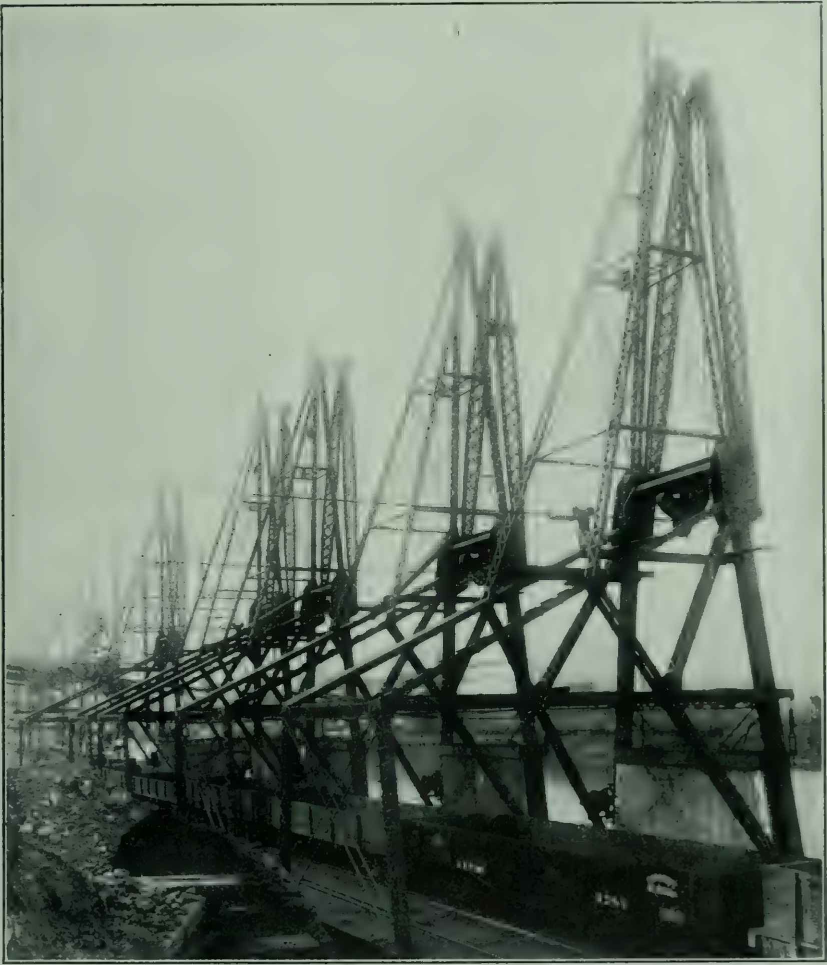
stone are handled in a shift of ten hours, by a machine equipped with a 75-horse-power boiler and 10 by 12-inch engine.

The picture on the left shows an interesting application of a cableway, as adapted to the fueling of locomotives with coal taken direct from the mine. The cableway is about 800 feet in length, and the buckets, which are loaded from a bin at the mine, are run out over the cable and dumped automatically into the bin over the railroad tracks. The coal is then drawn from this bin into buckets, where it is weighed and measured before being deposited in the tender of the engine. The buckets are counterweighted, so that as soon as the coal is dumped the buckets are lifted automatically into position, ready to be filled again. One man does all the work necessary for weighing the coal and loading the tenders, after the coal is deposited in the bin.

The lower picture on page 522 shows a cableway with movable piers



CABLEWAY AND LOCOMOTIVE FUELING PLANT, KING MINES, B. & O. R. R. BROWN HOISTING MACHINERY CO.



CABLE TRAMWAY FOR HANDLING ORE, N. Y. P. & O. DOCKS, CLEVELAND, OHIO.
With movable extension over the water. The Brown Hoisting Machinery Co., Cleveland, O.

or towers, as used in handling material from quarries, open-cut mines, in dredging canals, etc. The towers are placed on heavy trucks supported on wheels. Side rollers take the horizontal pull, and the towers are counterweighted, to prevent overturning. Back stays or permanent anchorages must, of course, be dispensed with where the towers are movable. The moving gear of the tower which carries the engine is coupled directly to the engine. The moving gear for the opposite tower is operated by moving the trolley back and forth along the cableway, suitable provision being made for attaching this mechanism to the racking ropes at the trolley.

Where cableways are used for handling material on docks, as in loading and unloading boats, the projection over the water must be so made that it can be raised up out of the way of the masts and rigging of the boat when the cable is not in use. Page 525 shows such an arrangement. The length of the cable is kept nearly constant with the projection (called an apron), either in the up or down position, guide sheaves and rollers being used to keep both the main cable and the racking and hoist lines in their proper relative positions.

In one type of cableway, only one line is used for supporting the load, raising and lowering it, and also for racking the trolley. Mr. Charles Hodgson took out patents on such an arrangement in 1868. Mr. Alexander E. Brown also has such a device.

AUTOMATIC ROPEWAY, KITTIE BURTON GOLD MINE, ULYSSES, LEMHI CO., IDAHO.

3200 ft. long, with a fall of 824 ft.; capacity 10 tons of ore per hour. The 1250-ft. span shown is the lower end. A. Leschen & Sons Rope Co., St. Louis.

Aerial Tramways.—Aerial tramways are merely a modified form of cableway. The principal differences are:—

First.—Cableways usually have only one main suspension cable; Aerial tramways have two. That is, the loaded buckets are carried on one cable, and returned empty on another; curves of sufficient radius being provided to allow the trolleys carrying the buckets to pass from one cable to the other at the end of the run.

Second.—Cableways consist of only one span, whereas the aerial tramway consists of a succession of short spans, say 300 or 400 feet in length. The total length of the cable may be several miles, and it is often carried down one hill-side, along a valley, and then, perhaps, up over a second hill. The supports at the top of the towers for carrying the cable, and the trolleys supporting the buckets, are so designed that the trolleys pass by these supports without interference.

AUTOMATIC TRAMWAY, NORTH AMERICAN COPPER CO., ENCAMPMENT, WYO.

16 miles long; capacity 40 tons an hour. Operated in three sections, one of 8 miles and two of 4 miles. A. Leschen & Sons Rope Co., St. Louis.

Third.—The cableways usually have only one trolley carrying one load. Aerial tramways have a succession of small buckets attached to trolleys, which are spaced at regular intervals along the entire length of the main cable. The buckets are usually of much smaller capacity than used on cableways, loads of from 500 to 1,000 pounds being perhaps about the average.

Aerial tramways are extensively used in mining and lumber regions, where steep slopes and irregular ground would render almost any type of conveying machine impossible. An example of this specialized service is shown in the marine cableway on page 523.

Industrial Railways.—Cars of small capacity, and made automatic or self-dumping, are extensively used in large manufacturing concerns for conveying coal, ashes, coke, and all kinds of material from point to point about the works. They are also extensively used in the construction of large excavations, and fills for railways, etc. The C. W. Hunt Company, of New York, are one of the largest manufacturers of this type of conveying machinery. The cars may run either upon the ground, or upon elevated trestles, or may even be suspended from overhead runways, in which case they would probably be operated by small electric locomotives of the suspended type. Compressed air has also been used to a considerable extent for this purpose. Such railways and their equipment are illustrated in the articles by Messrs. Waldron and Porter, elsewhere in this number.

Belt and Bucket Conveyors.—Various types of belts and endless

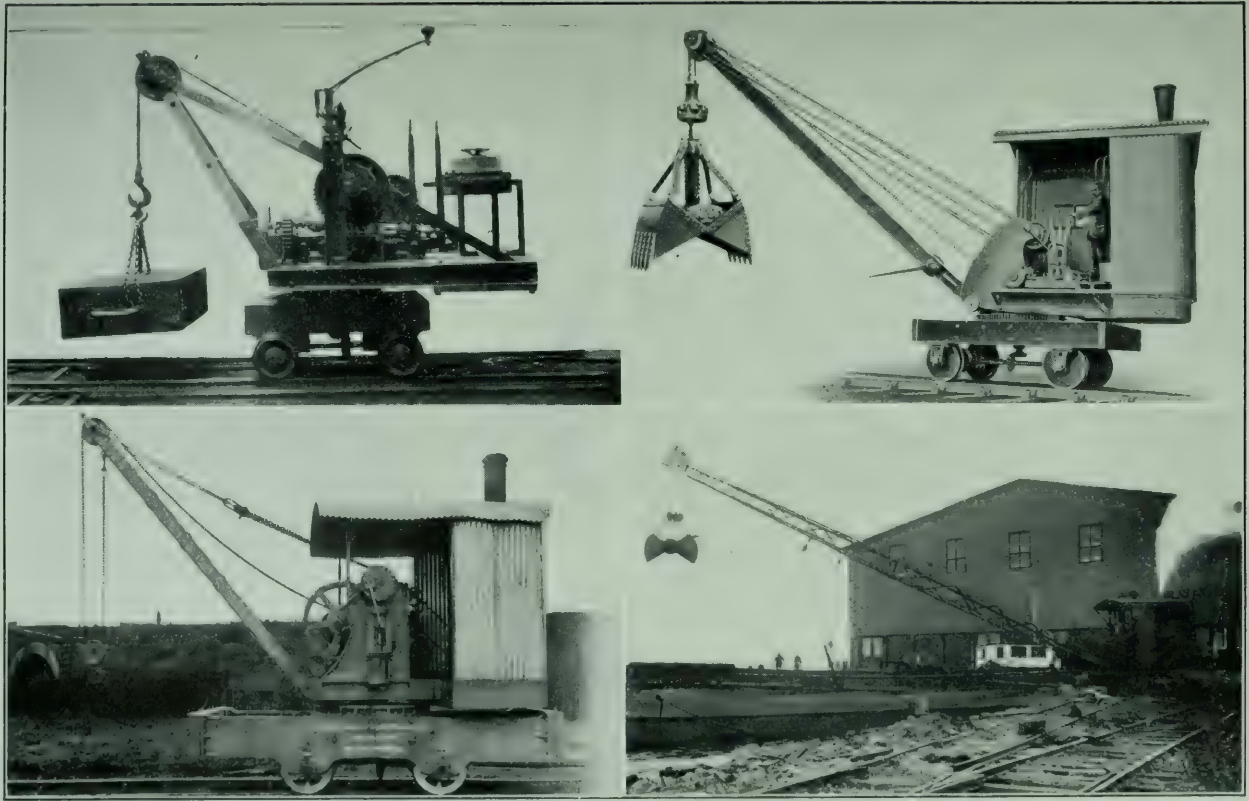
RIDGWAY BELT CONVEYOR, HANDLING SAND, STONE AND GRAVEL FOR A CONCRETE-MIXING PLANT.

20-in. belt, 350-ft. speed; capacity 125 yds. an hour. Ridgway Belt Conveyor Co., N. Y.

chains, to which small buckets are attached at frequent intervals, are used for carrying the output of mines and excavations up steep inclines, for distances of several hundred feet.

If a belt conveyor is used, the material will be dumped on to the belt through chutes, and the conveyor then carries it in an endless stream up the incline and deposits it at the top. The bucket conveyor takes up the material from a pit or trough, and as the buckets pass over the upper supports, they all, of course, turn over and empty themselves. Belt conveyors are shown in the illustrations on this page and page 531. A belt conveyor 32 inches wide will convey from 25 to 30 tons of ore per hour, the speed of the belt being from 30 to 60 feet per minute. Crushed stone has been carried on 16-inch conveyors at the rate of 200 cubic yards per hour. Thirty-six inch belts have been used in connection with dredges and have carried material, including broken stone, at the rate of 1,200 tons per hour a distance of 70 feet, the belt speed being 550 feet per minute. The maximum angle at which belt conveyors will work satisfactorily is about 25° with the horizontal.

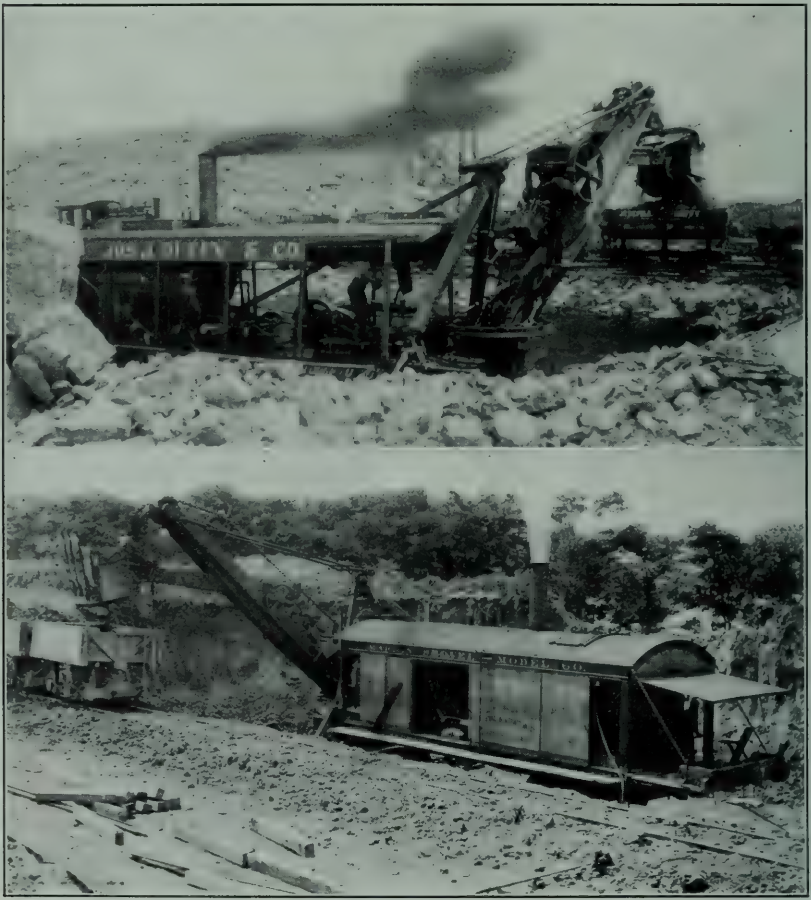
Locomotive Cranes.—The use of small locomotive cranes of 5 to 10 tons capacity, for handling coal, coke, ore, etc., and for excavating ditches and canals of moderate depth and width, has been very greatly increased during the last few years. This is due largely to the fact that grab buckets suitable for handling these materials have recently been placed on the market. Only one man is required to operate these cranes, and from 50 to 150 tons per hour are easily handled with them. Gondola cars can be rapidly unloaded, and the entire contents of the car taken out without the aid of hand shoveling. An illustration in Mr. Hatch's article, page 591, of this number, shows



EXAMPLES OF LOCOMOTIVE CRANES FOR CONTRACTORS' AND SIMILAR USE.

On the left, above, a 3 ton portable electrically driven crane by Jessop & Appleby Brothers, Ltd., Leicester; to the right of that, a steam crane and grab by the same makers; on the left, below, a steam crane, contractors' class, made in sizes from 3 to 10 tons, with radius from 14 to 12 ft., by Marshall, Fleming & Jack, Motherwell; in the lower right corner, a 10-ton locomotive **crane with 60-ft. boom, built by the Browning Engineering Co., Cleveland, O., for the Hudson Cement Co.**

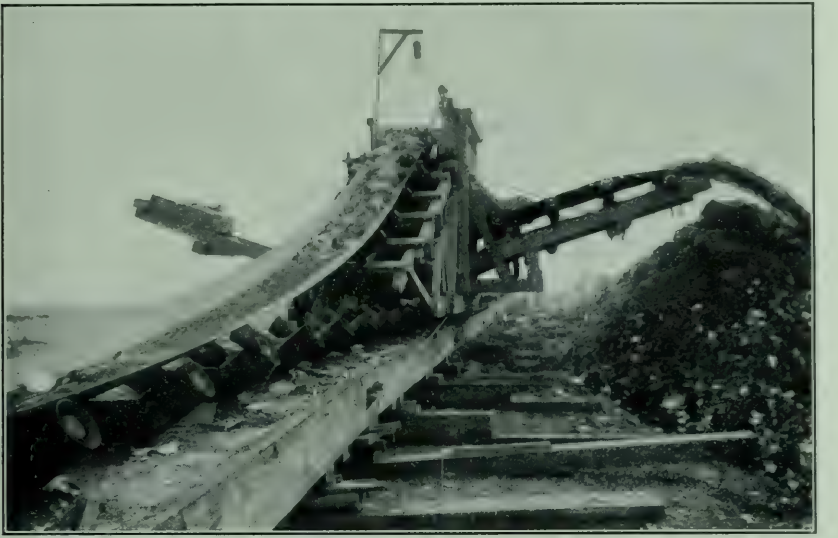
a locomotive crane unloading ore from cars, and depositing it in a stock yard, and other types are shown opposite. These cranes, being light, do not require the heavy foundations for carrying them which would be necessary for steam shovels. They are, of course, self-propelling, and can be made to handle their own tracks, picking up the sections which have been left behind the crane and placing them in position in front, only two or three short sections of track being required as the crane moves along from position to position. If the material conveyed can be deposited in piles along the sides of the cut, the locomotive crane does this work with only one handling of the material. These cranes have been built with booms of from 50 to 60



TYPICAL AMERICAN STEAM SHOVELS.

Above, a shovel built by the Vulcan Iron Works, Toledo, Ohio, working on the new power canal of the Chicago Sanitary District; below, a shovel by the Marion Steam Shovel Co., Marion, Ohio, working on the line of the Pennsylvania Railway.

feet in length, and it will thus be seen that a canal of considerable width could be excavated by them without moving the crane sideways. One important feature in their favor is the fact that only one man is required for operating the crane and handling the material.



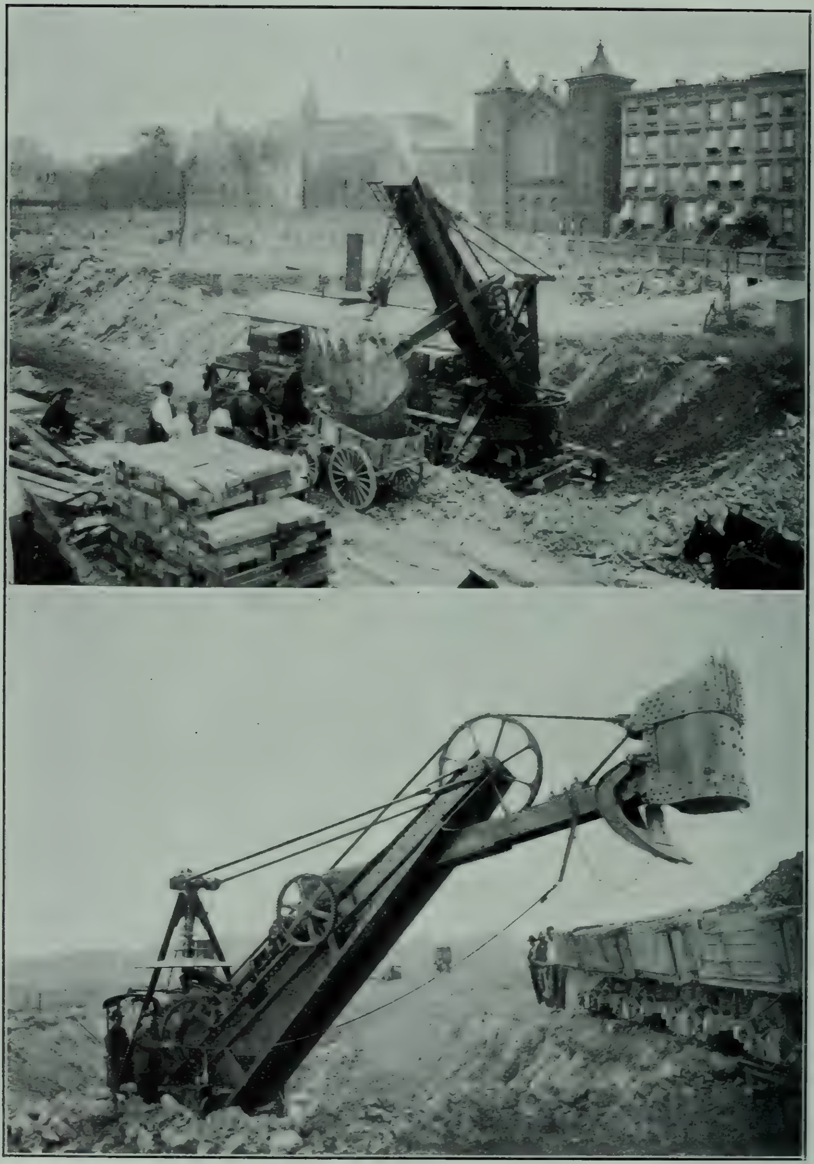
REFUSE CONVEYOR, RIKER'S ISLAND PLANT, N. Y.

The total length of conveyor is 1,000 ft., and of the belt about 2,000 ft.; discharge is made at any point by the movable tripper provided with an auxiliary conveyor, as shown. For general conveying, 10-in. to 36-in. belts are used, running 200 to 700 ft. a minute and handling 15 to 1500 tons an hour, according to kind of material and size and speed of conveyor. For picking or sorting ore, the Robins belt is made wide and flat-troughed and run at 30 to 50 ft. a minute. A 32-in. belt will handle 25 to 50 tons an hour.

Robins Conveying Belt Co.

Steam Shovels.—Up to the present time, no machine has been so extensively used for handling material from large railway cuts, in building embankments, and in moving the material from open-cut mines, as some type of steam shovel. (See pages 530 and 532).

Open-cut mines in the Lake Superior region are almost entirely worked thus. In excavating the Chicago Canal, a 60-ton machine handled about 600 cubic yards of hard cemented gravel in a day of 10 hours; 70-ton machines excavated about 700 yards. In stripping gravel drift at the Mesaba iron mines, a 65-ton machine, equipped with a 2½-cubic-yard shovel, has handled about 2,000 yards a day. The contract price paid for handling this material varies from 20 to 50 cents per cubic yard. In loading the ore itself, a 65-ton shovel will load from 70 to 80 cars of 25-tons capacity in 10 hours. A 70-ton shovel with a 2½-yard dipper, has handled ore in the Michigan fields at 2.53 cents per ton. Much heavier shovels are now being introduced, some weighing 100 tons or more.



TYPICAL AMERICAN STEAM SHOVELS.

At the top, a shovel built by the Bucyrus Company, South Milwaukee, Wis., working in the excavation for the new Pennsylvania Railroad terminal in New York City. Below, a new type of shovel, designed by Mr. A. W. Robinson and built by the American Locomotive Co., at work on a railroad cut.

The Bucyrus Company have over one hundred steam shovels in use on the iron ranges of Minnesota, Wisconsin, and Michigan. They use two classes of shovels. Shovels of 65 and 70-tons weight are used for stripping off the material over the ore, and 85 and 90-ton machines (the latter having a dipper of 5-cubic-yards capacity) are used for handling the ore itself. These machines are very heavily and substantially constructed throughout. There are three engines—the main engine operating the hoisting and propelling machinery, a smaller engine for swinging the boom and dipper, and a third engine for thrusting the dipper handle. Page 532, upper figure.

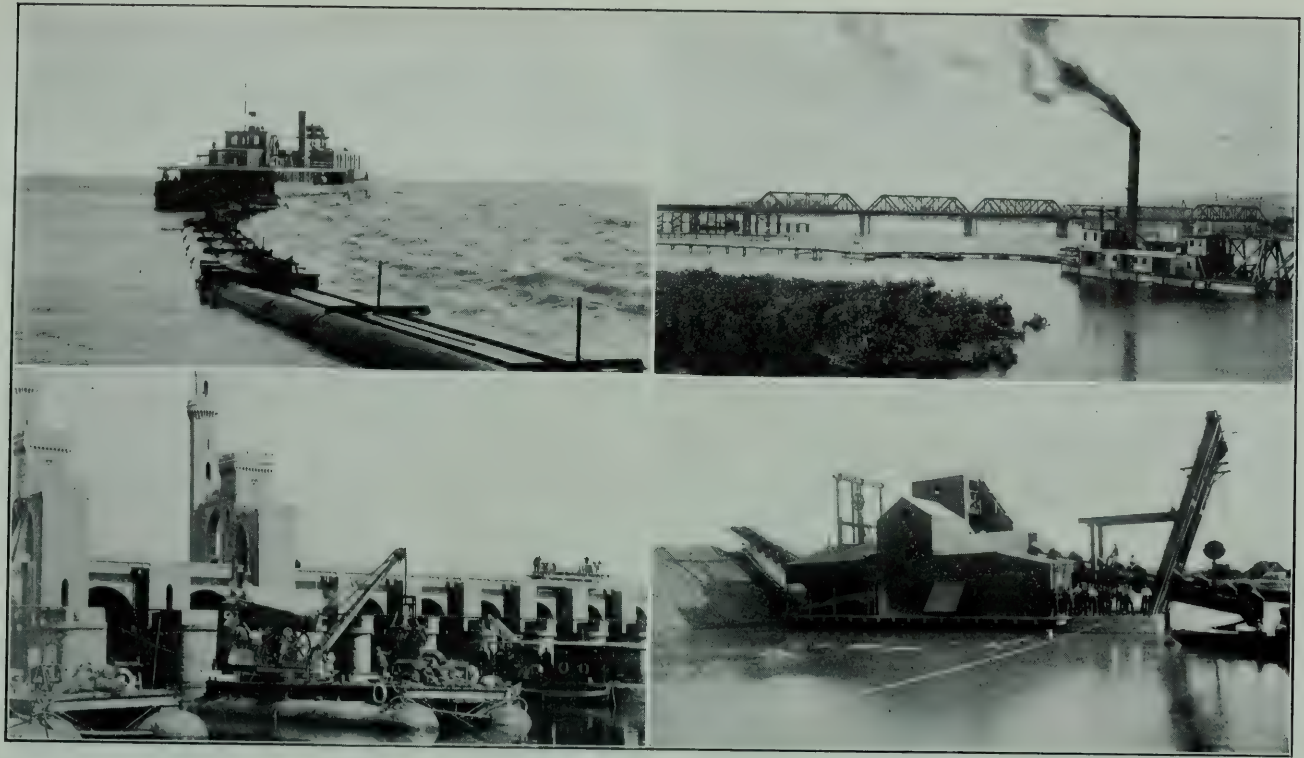
This company has a contract for thirteen shovels of 70 and 95-tons weight, to be used on the Panama Canal. The makers claim a capacity of 3,000 to 4,000 yards per day of 10 hours, and state that the 95-ton shovels have a record of handling material at the rate of 8,180 yards per day of 10 hours, including all stops.

The Vulcan Iron Works, of Toledo, Ohio, have five of their shovels at work on the construction of the power canal of the Chicago Sanitary District. This canal, running between Joliet and Lockport, Ill., is designed to furnish power for the city of Chicago. There will be excavated about 4,275,000 cubic yards of rock, and 105,000 cubic yards of earth. Some of the material handled requires machines of large power and of the strongest construction. The upper figure on page 530 shows one of these machines.

For stripping the coal fields in Kansas, a combination of shovel and belt conveyor is used. The shovel deposits its load in a belt made of heavy canvas which conveys the materials out to a distance of about 75 feet and dumps it. A shovel of one cubic yard capacity handled about 1,200 cubic yards in 10 hours. The belt has a speed of about 120 feet per minute, and a 50-horse-power boiler is used to operate both the shovel and the belt conveyor.

Dredges.—There are three prominent types of dredges; the dipper, the elevator or bucket type, and the hydraulic or suction dredge. The first is very similar to the steam shovel in design and operation. It is mounted upon a pontoon, instead of being mounted on wheels and running on tracks. This type seems to be a favorite for harbor and river work in the United States.

In Europe the elevator and hydraulic types seem to be preferred. Some of the larger dipper dredges have a dipper or bucket with a capacity of 4½ to 5 cubic yards. The quantity of material which can be handled per day varies from 500 to 1,500 cubic yards or more This, of course, depends entirely upon the capacity of the dipper, the character of the material, and the ability of the operating workmen.



TYPES OF DREDGES, OF VARIOUS CLASSES, IN ACTUAL OPERATION.

The dredge shown in the top left-hand quarter is the J. Israel Tarte, 160 x 42 x 12 ft., 1500 h.p., dredging in the St. Lawrence to a depth of 35 ft. and delivering through 2,300 ft. of pipe at the rate of 2,000 yds. blue clay per hour; built at the Polson Iron Works, Toronto, from designs by A. W. Robinson. To the right, above, is a hydraulic dredge of the Atlantic, Gulf & Pacific Co., N. Y., working at Albany N. Y. Below, on the left, are Kingston dredgers of the barge type, on wire pontoons, employed on the reconstruction of the lower barrage on the Nile. In the lower right corner is a bucket dredge working in gold ore.

For gold dredging in the Western States, the elevator or endless chain type is the favorite. These dredges excavate the gravel, screen and wash it, separate the gold, and then deposit the refuse or tailings. The buckets weigh about 1,000 pounds each, and the total weight of the machinery, on a dredge of this character, may be 500,000 pounds or more. The capacity of these dredges is from 50,000 to 75,000 cubic yards per month, or 2,800 cubic yards per day as a maximum. A 50,000-yard dredge would have engines of about 160 horse-power, and a 75,000-yard dredge would have engines of about 230 horse-power. The cost of handling material with these machines is from 5 to 7 cents per cubic yard. Page 534 shows one of these dredges in operation, and also several of other types.

One of these is one of the hydraulic dredges of the Atlantic, Gulf and Pacific Company, working at Albany, New York. These machines operate by swinging radially about a center spud, and are moved forward by using two spuds as alternate centers; a rotary excavator with a suction pipe opening within it is always present, but there are several methods of operating, depending on the character of material handled.

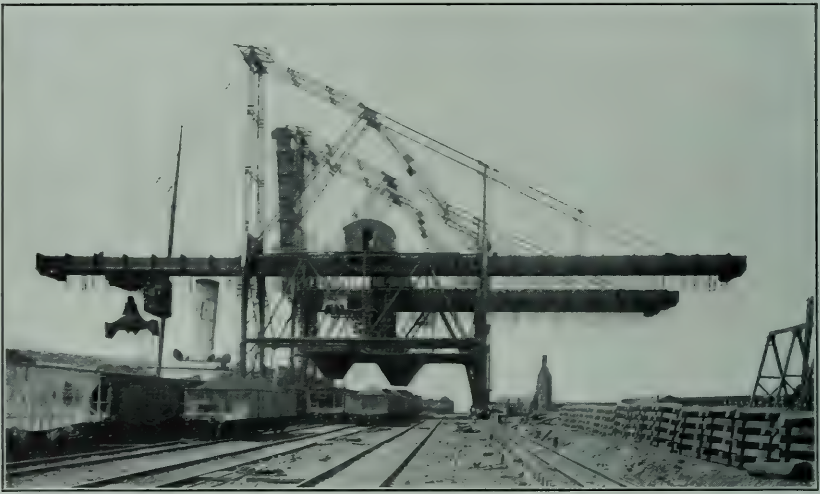
This company owns and operates dredges of 18, 20, 22, 24, and 30-inch sizes. The output, of course, varies according to the material handled, and the conditions under which the machine is working. Twenty-nine thousand cubic yards have been handled in one double-shift day, with a twenty-four inch machine. One machine has discharged material through 12,000 feet of pipe line. The machines owned by this company have handled approximately 60,000,000 cubic yards of material.

An elevator dredge at Cologne, Germany, has double bucket chains, and the capacity of the machine is about 260 cubic yards per hour. The capacity of the buckets themselves is about 35 gallons. Two engines of 250 horse-power are used.

At the North Baltic Canal, a bucket dredge with force pumps was used, which forced the material about 900 feet and elevated it about 6 feet, at the rate of about 260 cubic yards per hour. The engines were 175 horse-power.

Cranes.—Cantilever and gantry cranes of numerous types have been used extensively in the handling of materials at mines, ore docks, etc., and in the construction of canals and excavations. In building the Chicago Drainage Canal, one of the most successful machines used was a cantilever crane, having a trolley travel of 343 feet and a capacity on the hook of 5 tons, which is equivalent to a 2½ to 3-cubic-yard bucket loaded with stone. These cranes were built by the Brown Hoisting Machinery Company, of Cleveland. (See page 537). The engines used were 10½ by 12 inches. Eleven of these machines were used, and the average amount handled by each machine was about 540 cubic yards per day. The cost per day of operating one machine was $9.75, as follows:—

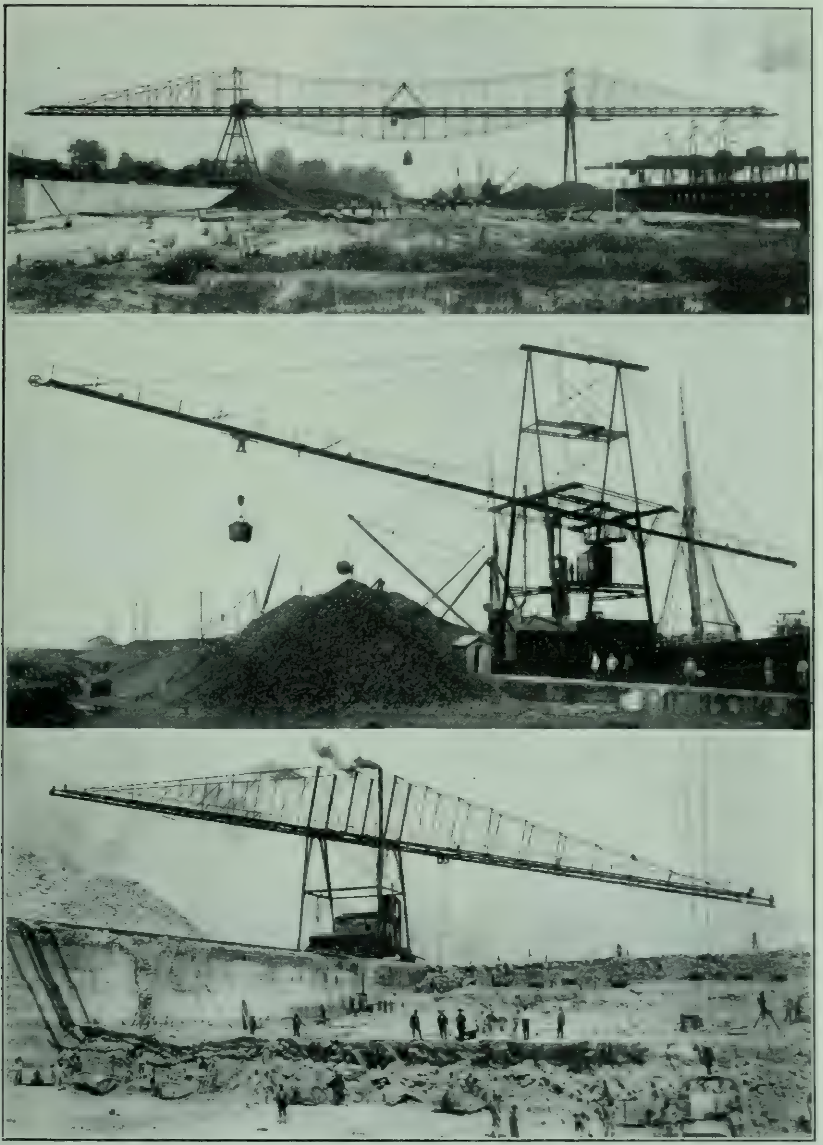
Engineer	$2.25
Oiler	1.75
Operator	2.75
Coal used	2.75
Water, oil, waste, etc.	25
Total	$9.75



5-TON UNLOADERS, DOCK OF THE PITTSBURG & CONNEAUT DOCK CO., CONNEAUT, OHIO.
The Brown Hoisting Machinery Co.

The cost per yard for handling material would be from 2½ to 3 cents. If these cranes were used for similar work today, much greater quantities could be handled, particularly if grab buckets were used for picking up such material as could be handled by them, and the cost per yard of material handled would not exceed 2 cents.

If the grab buckets were used, the number of men required to operate the machines would be very much less, and of course, the cost of the material handled would also be greatly reduced. This type of crane is extensively used in ship yards and similar places. There is little doubt that they would prove very efficient and economical in stripping ore mines, and in handling the ore itself in such locations as the mines in the Lake Superior region. It is a little surprising that they have never been used at these mines.



TRAVELING GANTRY AND CANTILEVER CRANES FOR HANDLING MATERIALS.

At the top is the plant of the Conneaut Dock Co., Conneaut, Ohio; next below is a traveling transporter for handling coal, iron ore, etc., supplied by the Temperley Transporter Co., London, to the Sociedad Viscaya, Bilbao. It lifts a gross load of 35 cwt. at a speed of 250 ft. a minute and transports it along the beam at 600 to 800 ft., handling over 60 tons an hour. At the bottom is a cantilever crane, digging the Chicago Drainage Canal; built by the Brown Hoisting Machinery Co.

There are many types of moving cantilever cranes. One of the most remarkable, perhaps, of these plants, is the Conneaut Dock equipment, at Conneaut Harbor, Ohio, shown on page 536. The buckets of the unloaders, although designed to take 5 tons of ore, will, when handling the softer ores, pick up 7 or 7½ tons.

The trolleys for the unloaders are placed on turntables, so that the bucket can be revolved after it has been lowered through the hatch, so as to reach the ore between the hatches. In a suitable boat the ore can be entirely removed without the aid of hand shovelers.

The large bridge crane is equipped with a 7½-ton bucket, and is used for storing such portions of the ore as are not required for direct shipment by cars. Some data relating to these cranes, are given in the list below:—

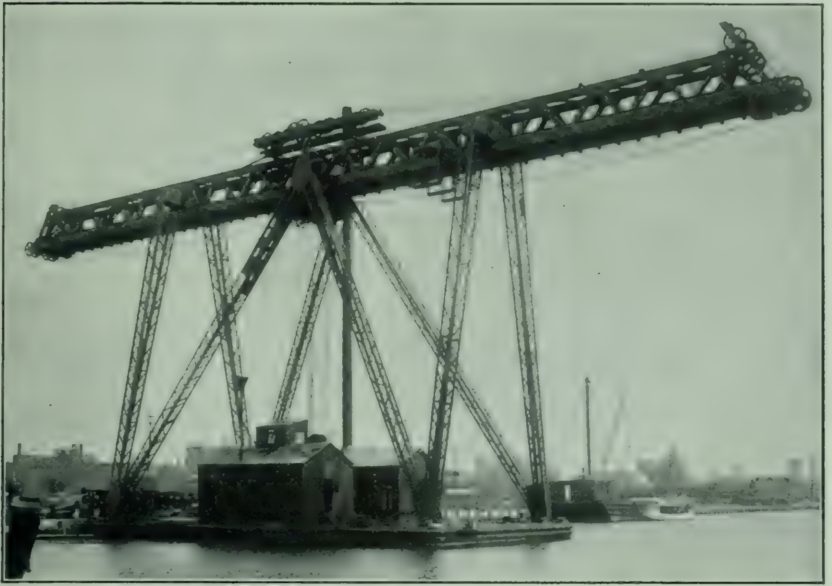
	Fast Plant. Pounds.	Bridge Tramway. Pounds.
Capacity of hook	20,000	28,000
Capacity of bucket	10,000	14,000
Total weight of crane	337,000	1,039,000
Total weight of trolley and bucket	59,400	69,000
	Fast Plant. Feet per minute.	Bridge Tramway. Feet per minute.
Speed of hoist	300	225
Speed of trolley travel	1,000	1,000
Speed of bridge travel	75	75

Motors.	Fast Plant.	Bridge Tramway.
Hoist	Two of 150 h. p.	Two of 150 h. p.
Trolley travel	One of 100 h. p.	Two of 75 h. p.
Bridge travel	One of 75 h. p.	One of 150 h. p.

In unloading the steamer Cornell, October 17th and 18th, 1904, the following record was made:—Total tons, 5,970; total number of buckets, 104; average per bucket for the first car, 7.7 net tons; average per bucket for eleven cars, 5.74 net tons; average per bucket for 77.7 per cent. of the cargo, 4.5 tons; tons per hour, 180. The cost per ton for handling did not exceed 7/10 of a cent.

Pontoon Cranes.—There are a great variety of pontoon cranes used on construction work in rivers and harbors, at government fortifications, etc. One of the largest and most interesting of this type of cranes is the 100-ton balanced crane recently built by the Brown Hoisting Machinery Company, for the New York Navy Yard. This crane has a trolley travel of about 190 feet. Loads can be hoisted 65 feet above the mean draught of the pontoon, and lowered to a depth of about 20 feet below this line. Two locomotive boilers of 80 horsepower are used for furnishing steam at 100-pounds pressure. The main engine is of the double cylinder horizontal type, with 12-inch by 15-inch cylinders.

Running on tracks, in the hold of the pontoon, there is a large

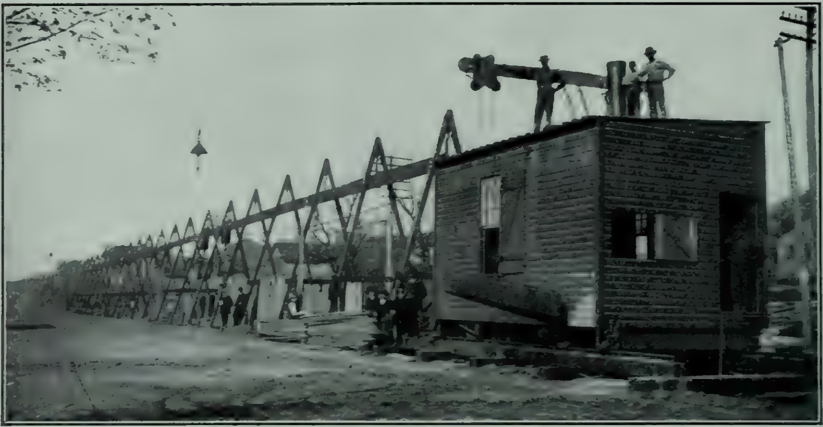


100-TON PONTOON CRANE AT THE NEW YORK NAVY YARD.
Built by The Brown Hoisting Machinery Co.

counterweight operated by a double-cylinder 7-inch by 9-inch engine, so arranged that whenever the pontoon tips, on account of a load being raised by the crane, the counterweight is immediately and automatically started in the opposite direction, and moved until the boat is brought to an even keel again, when its motion is automatically stopped. Six water-tight compartments are also provided, which can be used as desired in trimming deck loads. The crane will carry, in addition to the 100 tons carried at the end of the runway, a load of 300 gross tons on the deck. This crane is used for handling armor plate, guns, and other bulky material. It is shown above.

In order to determine what type of apparatus is best adapted to any particular undertaking, it is necessary to understand fully all the conditions under which the machinery must be operated. The character of the materials to be handled, and even the class of men who will be employed to operate the mechanism, must all be considered. Failure to understand fully all the items which would affect the working of a plant has been the cause of failure in much conveying machinery. It is not at all certain that a machine which has done excellent work under certain favorable conditions, will not be a failure if some of these conditions are even slightly changed.

A dipper dredge may be best adapted for handling hard material in harbor and river excavations, where the material is dumped into



A SEWER MACHINE.

It is essentially a movable overhead tramway, consisting of a track beam supported on A frames. On the tracks run carriers, to which are attached buckets for the material to be excavated and moved. Hoisting, lowering and traveling movement requires co-operation of the attendant at the excavation and the engineer in the engine house. Accidents are thus avoided. Maximum speed 800 ft. a minute. The Brown Hoisting Machinery Co.

scows. For handling light, loose material, where the conditions are favorable for discharging through long pipes, at a low cost, the hydraulic dredge may be better. For the peculiar conditions encountered in gold dredging, in certain parts of the Western States, the elevator or bucket type has been the favorite, as has been stated above.

In canal work, if the material has to be carried back long distances to be dumped, a cableway or some form of belt or bucket conveyor may be well adapted. If the distance over which the material is carried is only one hundred or two hundred feet, then a cantilever crane would be a very satisfactory machine, particularly if the material is such that it can be handled by grab buckets.

For loading directly on cars where the ground is solid enough to support heavy steam shovels, machinery of this type would, perhaps, give the best results.

For transferring material down rough mountain sides, over rivers, and across ravines, some form of cableway naturally suggests itself. There are many locations where a gantry traveling crane would be well adapted to perform rapid and economical work. The limited space allowed for this article permits the description of only a few of the most common type of machines. There are many other types which are, perhaps, equally worthy of mention, but which have of necessity been omitted.

THE MECHANICAL TRANSPORT OF AIR.

By Walter B. Snow.

BELLOWS APPLIED TO MINE VENTILATION.

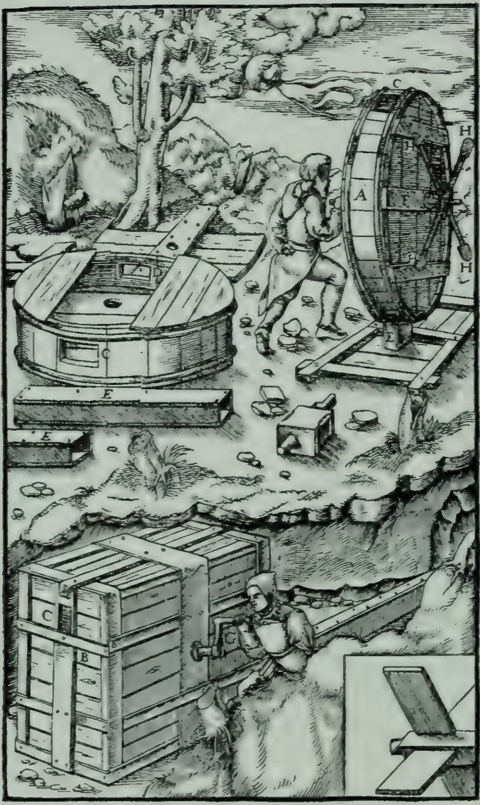
Agricola, "De Re Metallica," 1556.

WHOLESALE transportation of fluids is rarely accomplished by actual carrying, but almost universally by the process of flowing, which the derivation of the word fluid naturally suggests. As the river flows toward a lower level because of the lesser resistance, so air in atmospheric areas of high density rushes toward those of lower density, with resulting air movement or transportation upon a stupendous scale. But while in the case of water a pressure difference measured by a single inch of head creates but sluggish movement, the same intensity of pressure in the mobile air produces a velocity of about 45 miles per hour. For the economical movement of air in conduits this velocity, equivalent to nearly 4,000 feet per minute, is seldom exceeded. In fact, improved efficiency is to be sought by its reduction to the point where the decreased friction losses are offset by the increased cost of the conduit necessary to convey the desired volume at the lower velocity.

In the case of a gas, or a mixture of gases like air, it is manifestly the province of any system of transportation so to increase the pressure at one end of a conduit, or to decrease it at the other, as to establish a difference sufficient to create the required rate of flow. The theoretical velocity is determinable by the well known formula:—

$$V = \sqrt{2gh}$$

in which V is the velocity in feet per second; h is the head in feet or the pressure divided by the density; and g is the acceleration due to



ROTARY BLOWER APPLIED TO MINE VENTILATION.
Agricola, "De Re Metallica," 1556.

gravity, namely, 32.16. In practice the discharge orifice and the conduit restrict the freedom of flow, and a portion of the pressure, denominated the *pressure head,* is expended in overcoming this resistance; while only the balance of pressure known as the *velocity head* remains available for actual air movement.

For a given velocity the total frictional resistance to the movement of air in a pipe is proportional to its surface, or in the case of a round pipe to its diameter, while the pressure head per unit of area necessary to overcome this resistance varies as the ratio of the surface to the area, that is, inversely as the diameter. For illustration:—the total frictional loss in a 100-inch pipe will be ten times that in a 10-inch pipe, while the required unit pressure head will be only one-tenth as much in the former as in the latter. The power expended to overcome resistance is manifestly proportional to the total loss, and is measured by the product of the area into the pressure head per unit of that area. This power being utilized solely to create pressure head is of no direct avail in the actual movement of the air, for which additional pressure or velocity head must be provided. The sum of the pressure head and the velocity head obviously represents the total pressure difference which it is the province of any system to create.

The simplest of all methods of creating such a difference is by heating the air within a vertical conduit (of which the chimney is a familiar illustration) thereby reducing its density and inducing at the bottom an inflow of the cold and heavier outside air. Because of its simplicity, it was but natural that this method should have preceded the application of mechanical devices for artificial ventilation. But simplicity and efficiency do not here go hand in hand.

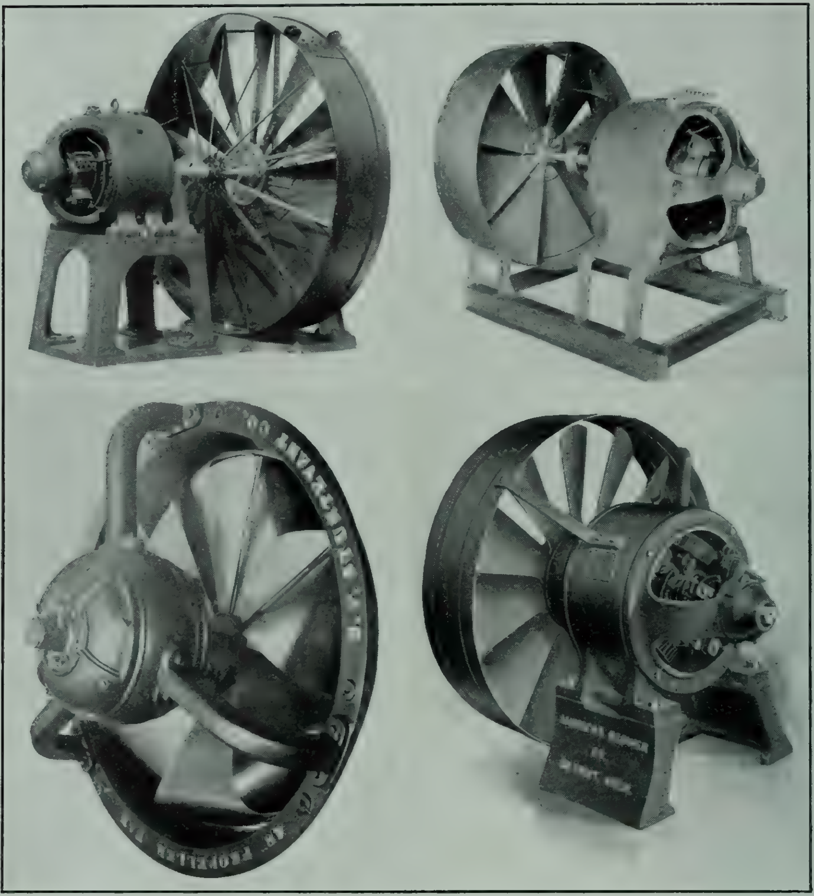
The bellows appears to have been the first mechanical contrivance utilized for the purpose of ventilation. The date of its invention is, however, buried in the dim past, although as early as 1556, Agricola in his elaborately illustrated work, *De Re Metallica,* shows this simple device, as well as a crude form of rotary blower applied for the ventilation of mines. The fan or centrifugal blower has, however, long been accepted as the only effective mechanism for creating wholesale air movement.

The air compressor, producing pressures up to 100 pounds or over, the blowing engine operating within the usual range of 10 to 20 pounds per square inch, and the positive or rotary blower seldom exceeding 5 pounds in the pressure created, are not primarily designed for mere movement of air, but more essentially for the creation of pressure and transmission of the same through the medium of the air. The propeller or disc fan, on the other hand, is efficient only under very low resistances and is incapable of economically forcing the air through conduits of very great length.

The maximum economical working pressure for the fan blower is well established at about one pound per square inch, but for the purposes of ventilation its rotative speed seldom exceeds that necessary to create a pressure of one ounce per square inch and a correspondingly velocity of somewhat over 5,000 feet per minute which, in general practice, is reduced to about 3,500 feet in the conduits, corresponding to about one-inch head of water.

The province of a fan wheel when in motion is to create such a pressure difference between the inner and outer diameters of the blades or floats as to cause a flow of air from the center to the circumference. The resulting action is well exemplified by rotating a tube about an axis established at right angles to its own and midway of its length. By centrifugal force the air is thrown outward from its open ends, and a partial vacuum created at the axis about which revolution occurs. If an opening be made at this axis, air will rush in to supply the vacuum and a constant flow will be established.

Much thought has been expended upon fan design, with many resulting arrangements of the fan blades and casings. Some blades are radial, some curved forward, and some backward, while others combine these forms; some fans are relatively wide and of small diameter, others of almost excessive diameter, but of minimum width; some run free in the atmosphere, while others are equipped with casings of varied design. In all these forms the effort has ever

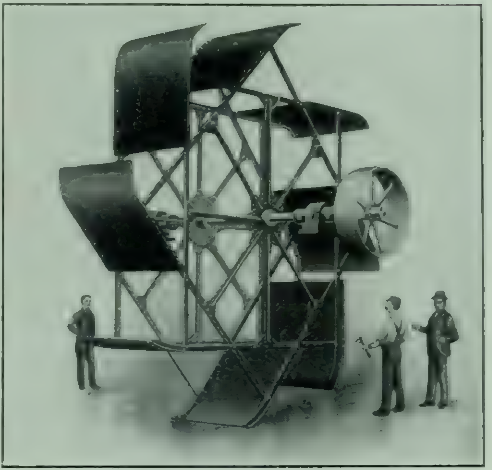


FOUR TYPES OF ELECTRIC-DRIVEN VENTILATING FAN UNITS.

In the left upper corner, direct-connected fan by S. B. Stine & Son, Osceola Mills, Pa., to the right of it, 4-ft. fan for auxiliary mine ventilation, 30,000 cu. ft. of air per minute, 10 h.p. motor, made by the General Electric Co.; in the lower left corner, electric propeller fan of the B. F. Sturtevant Co., to operate at 300 revolutions, create .85 in water pressure, and deliver 11,000 cu. ft. of air; lower right corner, disc fan wheel with direct-connected Westinghouse motor, American Blower Co.

been to improve the efficiency; but frequently greater volume or pressure has been secured only by increased expenditure of power. In fact, the simpler still remains not far behind the more elaborate in economy of operation.

The effect of high velocities is clearly shown by the fan, in which doubling the rotative speed simply doubles the volume discharged, while producing four times the pressure and requiring eight times the power. That is to say, the volume varies directly as the number of revolutions; the pressure varies as the square, and the power

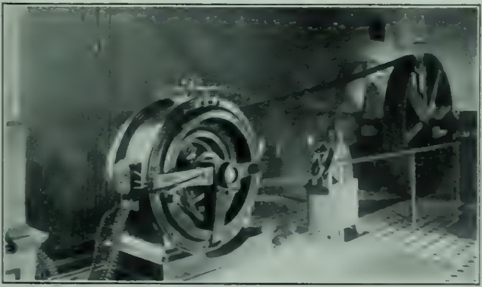


MINE FAN, GUIBAL TYPE.
Made in sizes 14-ft. diameter and upward. American Blower Co.

required as the cube of the revolutions. It is therefore evident that a fan which is only half large enough to move the desired volume at the required pressure will have to be run at double the speed, and will absorb eight times the power necessary to operate a fan of proper proportions. In a word, a fan should be so proportioned to its work as to make possible the delivery of the necessary quantity without exceeding the minimum permissible pressure.

In no line of industry requiring air movement upon a large scale has the efficiency of its movement received more careful study than in the case of the modern mine, with its miles of underground workings located thousands of feet beneath the surface. Here ventilation is imperative if human labor is to be continued. That the volumes handled are necessarily large is evidenced by the estimate that the weight of air passing through the coal mines of the United Kingdom is approximately twenty times that of the coal taken out.

Whether a fan shall be installed to force the air into the mine under the plenum system, or to exhaust it under the vacuum system, is dependent upon the character of the mine, frequently modified to large degree by the personal preferences of the manager; for the superiority of neither system is finally established. The very general application of the latter system throughout the United States is, however, fair evidence that it best meets the requirements in the average mine.



MINE VENTILATING FAN, KOENIGIN LOUISE COLLIERY, ZABORZE.

75 h.p., three-phase motor. Allgemeine Elektricitäts Gesellschaft.

Mine-ventilating fans operating upon the exhaust principle may be classed into three leading types.

1.—The open running, in which the fan wheel is devoid of casing and delivers the air freely around the entire circumference.

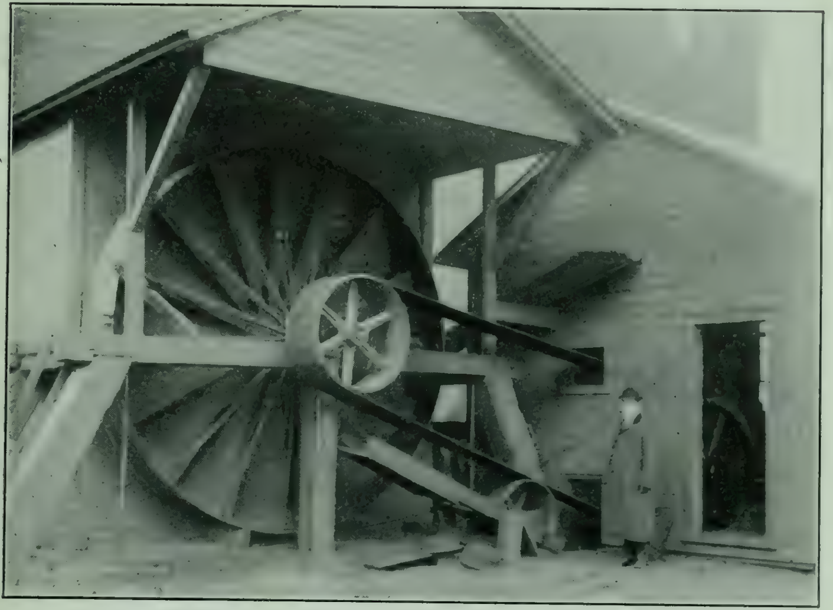
2.—The close cased fan with expanding chimney, which permits of the gradual reduction of velocity and pressure of the air delivered, thereby reducing resistances and increasing efficiency.

REVERSIBLE MINE VENTILATING FAN, 20-FOOT WHEEL, 9-FOOT FACE.
Edna No. 2 mine, United Coal Co., Irwin, Pa. Installed by Robinson Machine Co., Monongahela, Pa.

3.—The spiral cased fan with expanding chimney. The involute form of the casing provides a constantly increasing space for movement of the air after leaving the tips of the wheel blades and permits of free discharge with minimum resistance through the special form of outlet.

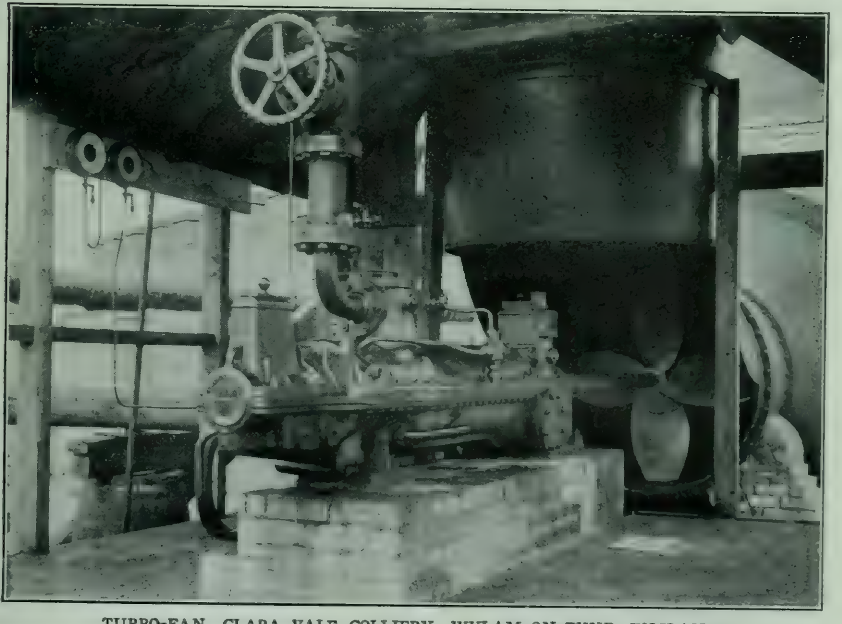
The form of the case and the design of the outlet have a large influence upon the efficiency. In English practice there has been a tendency to cling to the second type, in which the efficiency seldom exceeds 60 per cent., while in America the third type has been generally installed with efficiencies sometimes running up to 70 and 80 per cent. Peripheral velocities usually average between 5,000 and 6,000 feet per minute, the rotative speed depending, of course, upon the fan diameter, which, in English practice, runs up to 35 or 40 feet.

The railroad tunnel, with its volumes of locomotive smoke and its high temperature, presents a most difficult problem in air transportation and ventilation. Its successful solution is to be credited to the Italian engineer, Saccardo, who first applied his method in



MINE FAN, MORRISDALE COAL CO., MORRISDALE, PA.

12-ft. diameter, capacity 75,000 to 100,000 cu. ft. per minute. One of four installed by S. B. Stine & Co., Osceola Mills, Pa.

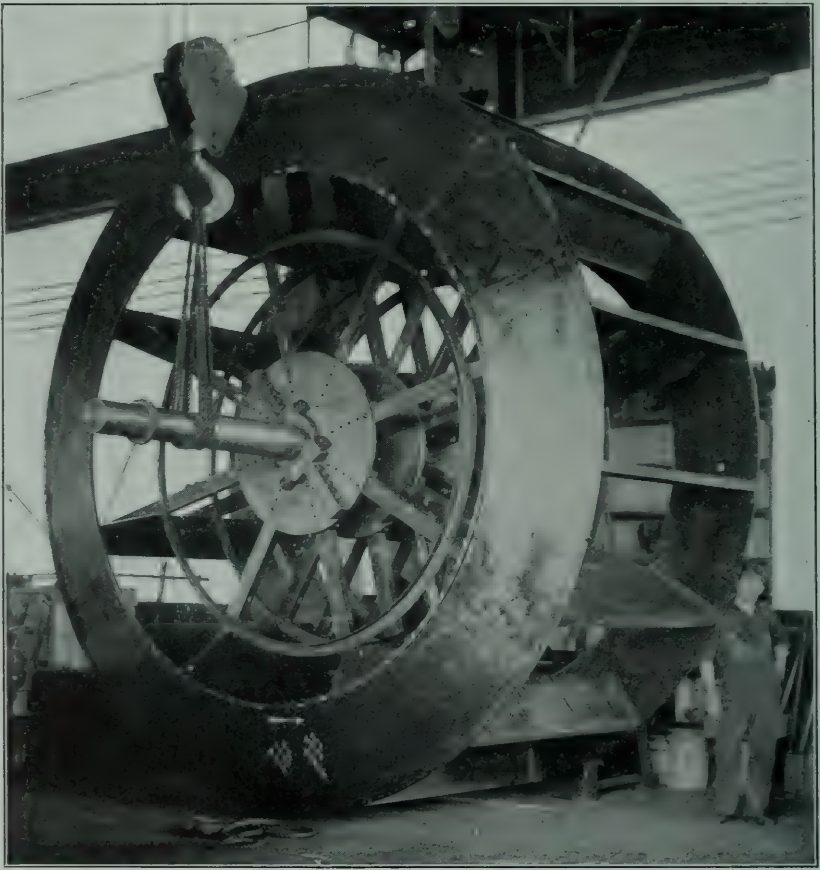


TURBO-FAN, CLARA VALE COLLIERY, WYLAM-ON-TYNE, ENGLAND.

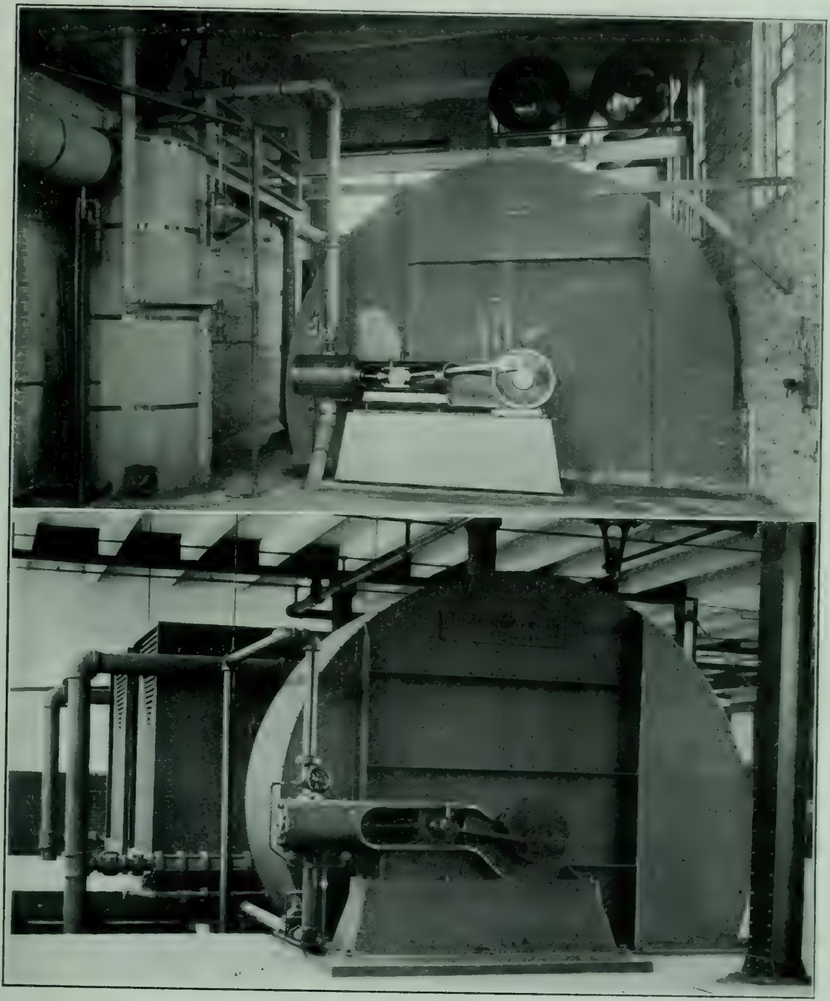
5-ft. diameter; capable of passing 100,000 cu. ft. of air per minute at 2-in. water gauge. C. A. Parsons & Co., Newcastle-on-Tyne.

the construction of the Pracchia tunnel. Similar applications have since been made in the United States with marked success. In this system the air is forced into an annular space arranged around one entrance and thence discharged longitudinally into the tunnel. Acting upon the injector principle, it induces an inward flow of the outer air through the regular tunnel entrance. The fan blower is absolutely necessary to secure these results, although only a portion of the air actually passes through the fan. The rate of flow is so regulated as to exceed that of regular trains passing through the tunnel, with the surprising result that the smoke is blown ahead of the locomotive, leaving the train in a clear and fresh atmosphere.

In all systems of ventilation the air plays a two-fold part. It not only meets the needs of respiration, but in the process of movement



A 16-FOOT TUNNEL VENTILATING FAN.
To operate at 140 revolutions, 3.25 in. water pressure, and deliver 250,000 cu. ft. of air per minute under working conditions. B. F. Sturtevant Co., Hyde Park, Mass.



MECHANICAL HEATING AND VENTILATING INSTALLATIONS.

The upper one was installed for the National Electric Co., Milwaukee, by Wm. Bayley & Sons Co., Milwaukee. 12-ft. fan, 82,000 cu. ft. air per minute at 100 revolutions; heats shop 200-ft. square and 3 stories high, 400-ft. away, the air being carried through galvanized-iron ducts and tunnel. The lower installation is the B. F. Sturtevant Co.; two 10-ft. wheels driven by 9 by 12 horizontal engines; 20,000 lineal ft. of pipe in heater; delivers 150,000 cu. ft. of air per minute and heats 3,000,000 cu. ft. of space.

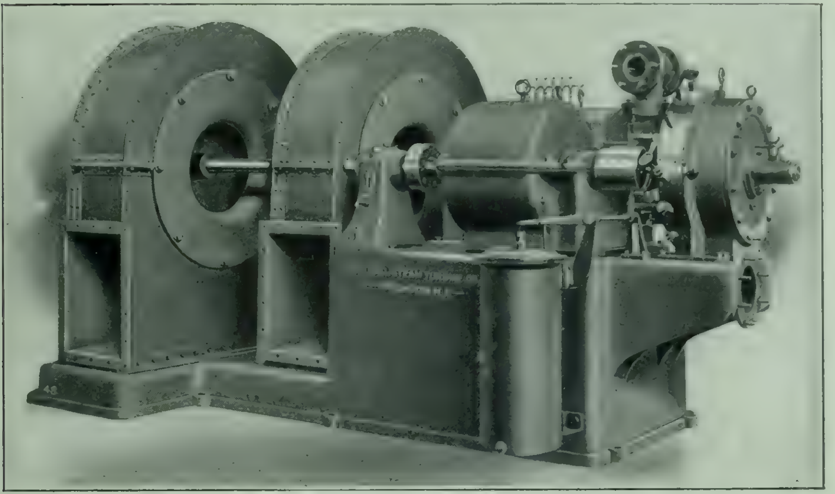
serves as the medium by which impurities are removed or heat is transmitted. The modern system of mechanical ventilation and heating depends for its success upon this dual property. The fan serves to supply air in quantity to meet the requirements of ventilation, while a primary heater established in connection with the fan transfers to the air sufficient heat to make good the losses by radiation, conduction, and direct escape of air from the apartment to which it is delivered. The more rapid the air change the less the temperature increment required.

A supply of 30 cubic feet per minute per individual is essential to even fair ventilation, while 50 cubic feet is necessary to produce a feeling of freshness in the atmosphere of an occupied room. The difficulties in the way of securing imperceptible ventilation are measured directly by the frequency with which the air must be changed within an apartment. In a large room, sparsely occupied, a half-hourly change is usually sufficient for satisfactory ventilation, while in a crowded audience room fair ventilation may hardly be secured by a complete volumetric change ten or twelve times per hour.

A LARGE MECHANICAL HEATING AND VENTILATING INSTALLATION.
The United Railways, Baltimore. Building 478 by 368 feet, served by four ¾-housed fans.
American Blower Co., Detroit, Mich.

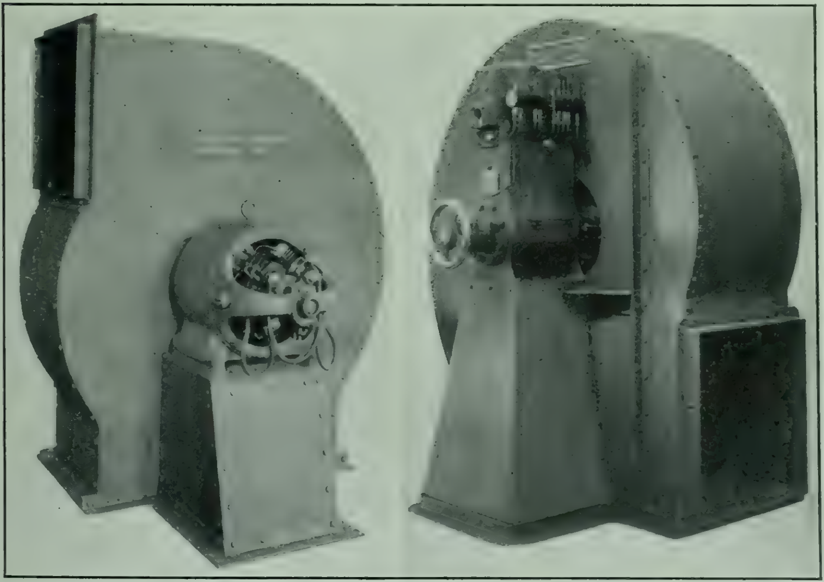
In a modern school building, with class rooms designed to allow about 250 cubic feet of space for each pupil, a supply of 30 cubic feet per minute per capita is equivalent to renewing the entire volume in the room once in about eight minutes. A supply of 50 cubic feet under similar conditions marks the attainment of excellent ventilation and is sufficient to change the air once in five minutes.

Heated flues are not only utterly inadequate for the movement of the air in such volumes, but are also excessively inefficient as compared with the fan, which may be employed to force the air



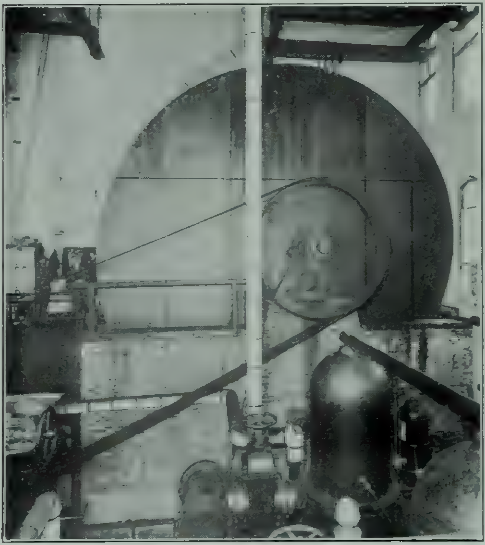
150-HORSE-POWER SIROCCO-BLOWER DIRECT-DRIVEN BY STEAM TURBINE.

through hundreds of feet of duct. In refined systems of ventilation the velocity of the air in process of transport usually ranges from about 2,000 feet per minute in the distributing mains, down to about 300 feet at the registers, while in factory practice, where the opera-



FORCED DRAFT FANS.

On the left, a full-housed 70-in. fan with direct-connected motor, delivering 11,700 cu. ft. of air at 623 revolutions. Wm. Bayley & Sons Co., Milwaukee. On the right, a 90-in. engine-driven fan by the B. F. Sturtevant Co., 500 revolutions, delivering 20,000 cu. ft. of air per minute at 3.5 in. water pressure.



FORCED DRAFT FAN, WORKS OF THE N. Y. GLUCOSE CO.

American Blower Co.

tives are usually in motion, main-duct velocities may be carried up to 3,500 feet per minute, and correspondingly high deliveries permitted if opportunity is given for the thorough breaking up of all currents before they reach the individual.

The more actively employed is the operative the less will he realize the movement of the air about him. Hence, one or two points of delivery with a limited distributing system may be all that are required in the boiler shop, while the refinement of an elaborate arrangement of outlets through which the air is discharged at lower velocity may be essential in the watch factory.

The fan is today rapidly superseding its predecessor, the chimney, as a means of draft production for steam boilers. Employed as a mere substitute for the chimney it may be installed upon the induced or suction principle, with short stack extending just above the roof and operated to create a pressure difference of 1 to 1½ inches of water. As an accessory to the chimney, particularly in an old plant or in combination with mechanical stokers, the fan finds ready application under a forced-draft system and may be operated at pressures up to even 3 or 4 inches of water, as is ofen necessary in marine practice or with some forms of mechanical stokers. For ordinary grates and fuel in stationary plants, the fan is seldom speeded to create a pressure of over 1½ to 2 inches at the outlet. Mechanical draft is, in effect, but the furnishing of air in sufficient volume for the lungs of the furnace, as is ventilation the equivalent supply of air for the human lungs.

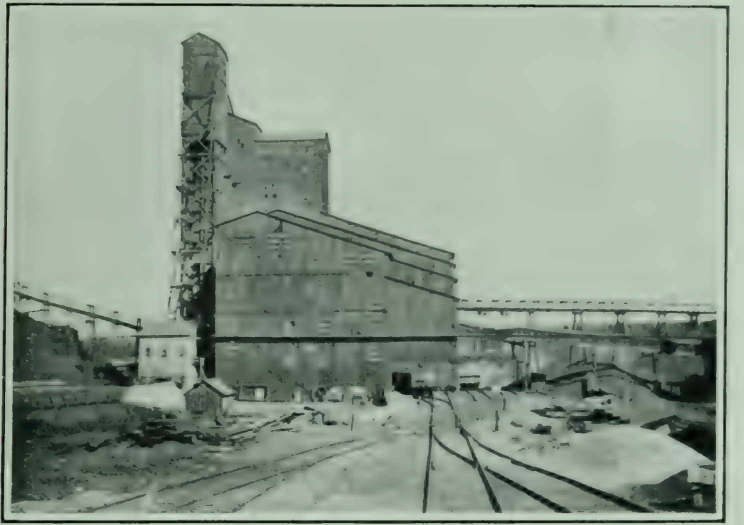


Fig. 1. An Anthracite Breaker; Coxe Bros. & Co., Inc., Beaver Meadow; Showing Tower for Dumping Cage.

LABOR-SAVING DEVICES IN COAL MINING.

By R. V. Norris.

Mr. Norris' article is fitly grouped with the preceding two, since it carries the study of the same elements (labor-saving and mechanical-transport appliances) into the third great field of engineering activity—mining. And the concrete example chosen—coal mining—lies close to the foundation of almost all modern power applications.—The Editors.

In looking back over the twenty years from 1903 to 1883 in the anthracite mines, we find that in 1883 there were mined 35,703,009 tons by collieries employing 56,270 men and boys inside, and 35,153 outside; while in 1903, for a production of 67,171,951 tons, there were employed but 102,055 inside and 49,772 outside—or in 1883 one employee inside for 635 and one outside for 1,016 tons, and in 1903 one employee inside for 658 and one outside for 1,350-tons production. This comparison is a little in favor of the earlier year, when the colleries worked an average of 218 days against an average of 211 in 1903.

From this it is evident that while great economies in labor have been made in the surface handling and preparation, but little net improvement has been made in the underground work. This is accounted for by the great extension of all collieries both longitudinally and in depth, and also by the much smaller and poorer seams now

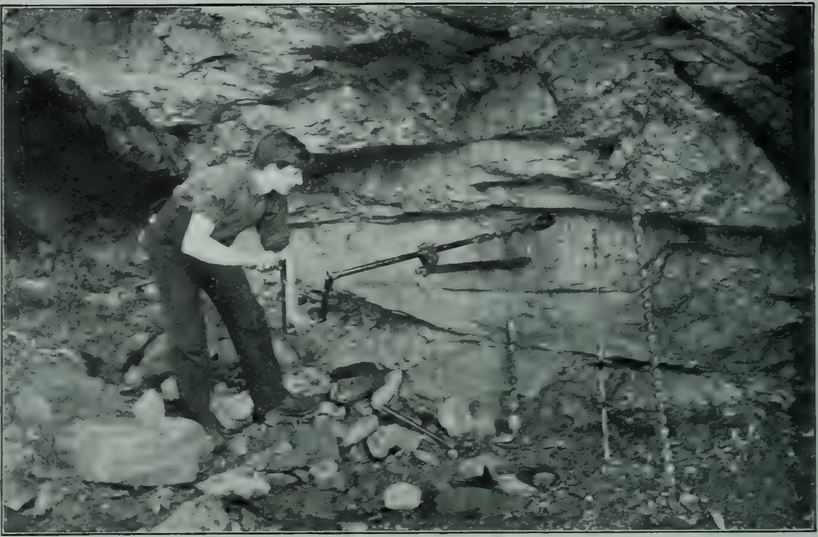


FIG. 2. THE "SPRY" HAND DRILL WITH STEEL AUGERS AND ADJUSTABLE BIT ENDS.
Howell's Mining Drill Co., Plymouth, Pa.

being worked; these disadvantages have apparently nearly balanced the improvements in transportation, pumping, and ventilation which have been made in the past generation.

The outside economies are even greater than appear by the tonnage, as the quality of preparation of coal has very greatly improved until less than 2 per cent of slate is now tolerated in the larger sizes, while 15 per cent. and even more was usual twenty years ago.

Taking up the improvements they may be classed thus:—

INSIDE		
	Mining	Mining methods. Drilling and blasting. Handling.
	Transportation	Mine cars. Haulage. Track.
	Hoisting	Engines. Cages. Safety appliances
SURFACE		
	Transportation	Haulage. Track. Car hoists. Conveyors. Elevators.
SURFACE (Continued)		
	Preparation.	Picking platforms. Rolls. Screens. Automatic pickers. Jigs. Disposal or refuse.
	Steam Plants.	Boilers. Grates. Mechanical draft. Economizers. Stokers. Pipe Covering.

The Engineering Magazine

All of these points show notable improvements; and while a full discussion of many of them is hardly within the scope of the present article, a brief survey it is hoped may prove interesting.

The changes in mining methods are generally an advance in degree rather than in principle, the main improvements being in the line of better and closer mining, and more thorough recovery of the coal; to these should be added the actual advance in filling the old workings with culm slushed in through bore holes by the use of water, to support the roof and thus permit the recovery of a larger percentage of the coal in the ground, and the increasing use of steel and masonry instead of timber for the support of the mine roof in important openings.

The miner has eased his labor and increased his hourly output by the use of boring machines (Figure 2). These are usually of very simple construction, consisting essentially of a support wedged into the coal and a feed screw carrying a twist drill revolved directly by hand power; some few air and electric drills are used, but their application is limited to places where power is available, which in anthracite mining is not generally the case. While many undercutting machines are used in the bituminous region, they are not used in the anthracite on account of the exceeding hardness of the coal and a general lack of a soft "mining bench" underlying the seams, and because the prevailing room and pillar system of mining is not especially suited to their use.

The greatest advance inside has been in transportation, especially in the replacement of the original long-eared compound engine by air and electricity; this, as it is covered in another article, I shall only touch on to call attention to the advance in track construction, which twenty years ago was of the lightest—usually 16 to 20-pound rails, or even 3 by 5 inch wooden tracks—and has now advanced to 30 to 40-pound rails for main gangways and 60 to 80-pound for slopes, with really respectable frogs and switches; and to the advance in mine cars and running gear (Figures 3 and 4). The car of 1883 was entirely of oak, usually with plain loose outside wheels secured by cotter pins through the axles; these were lubricated (?) through an oil hole in the hub *at* which a boy squirted half a pint or more of oil whenever they came to the surface, with the result of fully oiling the ground along the breaker tracks. This type of running gear has generally been replaced by closed-hub self-oiling wheels using less than 1/5 of the old allowance of oil and reducing the running friction by 40 per cent.* The latest advance for outside wheel cars is the use of

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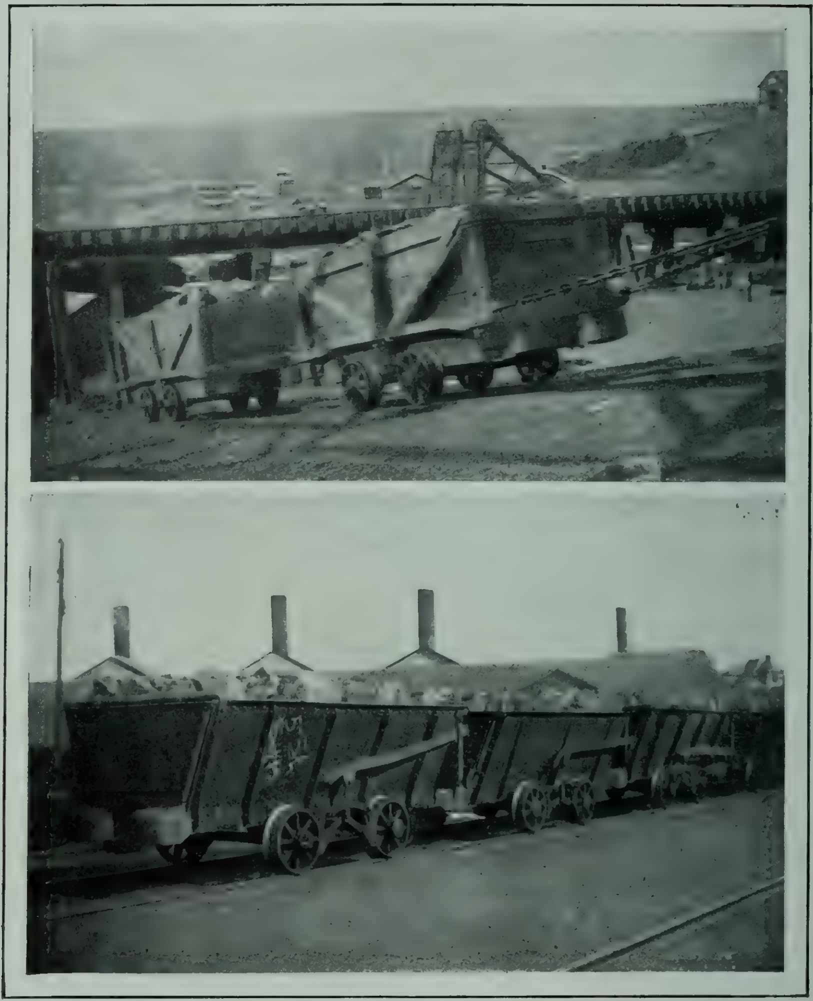
* Trans. A. I. M. E. Vol. XVIII, p. 508.



FIGS. 3 AND 4. THE UPPER PICTURE SHOWS OLD-TYPE WOODEN MINE CARS WITH PLAIN WHEELS; THE LOWER ONE, MODERN STEEL CARS OF 100-CUBIC-FEET CAPACITY, 3,400-POUNDS WEIGHT, IN USE BY THE SUSQUEHANNA COAL CO., NANTICOKE, PA.

one fast and one loose wheel (Figure 5) which has the advantage of permitting the car to take properly the very sharp curves necessary in a mine, gives the advantage of a turning axle concentrating the wear on a removable brass in the journal box, and permits the "spragging" of one wheel. All-steel cars are just beginning to come into use; those shown just above were the earliest and were put in use only about a year ago; they have thus far been very successful and promise to come into quite general use. In car wheels the greatest advance is in the use of manganese steel, giving much lighter and tougher wheels, and ones which do not readily wear flat.

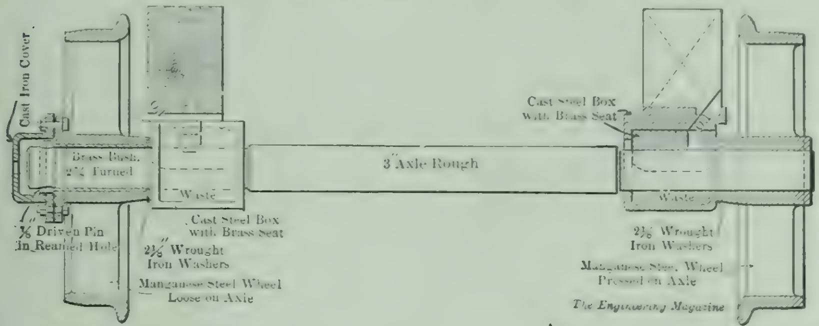

Cast Iron Cover
Brass Bush. 2½ Turned
⅞ Driven Pin In Reamed Hole
Waste
Cast Steel Box with Brass Seat
2⅛″ Wrought Iron Washers
Manganese Steel Wheel Loose on Axle
3″ Axle Rough
Cast Steel Box with Brass Seat
Waste
2⅛″ Wrought Iron Washers
Manganese Steel Wheel Pressed on Axle
The Engineering Magazine

FIG. 5. RUNNING GEAR FOR MINE CARS; CAST-STEEL BOXES WITH BRASS SEATS. FAST AND LOOSE MANGANESE-STEEL WHEELS.

In hoisting practise has come the enlarged use of first-motion engines directly connected to large drums, the change from wooden to steel shaft cages, and the use of dumping cages. These take the loaded car at the foot of the shaft and automatically dump it without removal at the head, doing away with the greater part of the large head force required for handling the empty and loaded cars. The application of dumping cages is of course limited to locations where the coal dumped at the head of the shaft can be put either directly into the breaker or taken into it by conveyors, and in many if not most cases they are installed in breaker towers to take the loaded mine cars from the surface to the dump, thus avoiding the use of elevators or conveyors. As the Pennsylvania mine law requires a distance of 100 feet between the shaft and the breaker, their use for direct hoisting into the breaker itself is limited to plants erected before the enactment of the present law in 1891.

In landing cages, both at surface and bottom, pneumatic keeps are coming into use, the cage landing on a piston upheld by a spring and sinking into a cylinder the air in which escapes through a small opening; these permit of more rapid landing without dangerous jars. Crossover trucks for handling cars at the heads of shafts avoid the usual complication of switches and somewhat reduce the head force, while caging rams with long strokes, operated either by air or steam, pushing the empty car on and the loaded off the cage, are in satisfactory use at a few plants.

The pumps two decades ago were mainly simple, non-condensing direct-acting pumps, frequently of long stroke, 6 feet being very common, and running at a slow plunger speed, with a duty of perhaps 20,000,000 foot pounds per 1,000 pounds of steam; while in the latest plants compound and triple-expansion condensing pumps are installed, and in one case at least, high-duty pumps of the flywheel type, with compound condensing Corliss engines. The pump houses, too, are now usually fire-proof, either driven in rock or lined with masonry, a lesson taught by the many mine fires starting in the old timber rooms.

After reaching the surface, anthracite is taken to the breaker and there sized and cleaned to a merchantable article; the handling between the mine opening and the breaker has been the subject of much attention resulting in immense improvement in the saving of time and labor. The general methods of handling may be classified as:—

Rope, Chain.
Locomotive, Conveyor,
Mechanical and Gravity, Elevator,

all liable to be inter-dependent, the system adopted being usually a combination of two or more of the above.

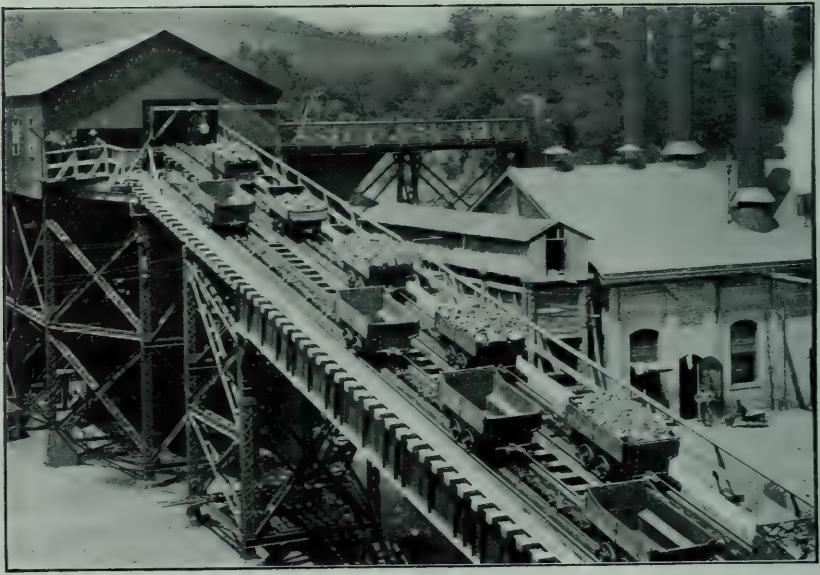


FIG. 7. CAR HOIST OF THE NATIONAL MINING CO., TREVESKYN, PA.
Installed by the Link Belt Engineering Co., Nicetown, Philadelphia.

As mine cars require fully 2 per cent. grades for proper handling, gravity alone can be adopted for one direction only, the empty cars being returned to the mine opening, if near at hand, by rope or chain haulage,* or by the use of a light car hoist to elevate the cars at the breaker sufficiently to permit their return to the mine opening by gravity. This consists of a plane, usually of very moderate pitch, on which

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* Trans. A. S. M. E. Vol. XII, p. 626.

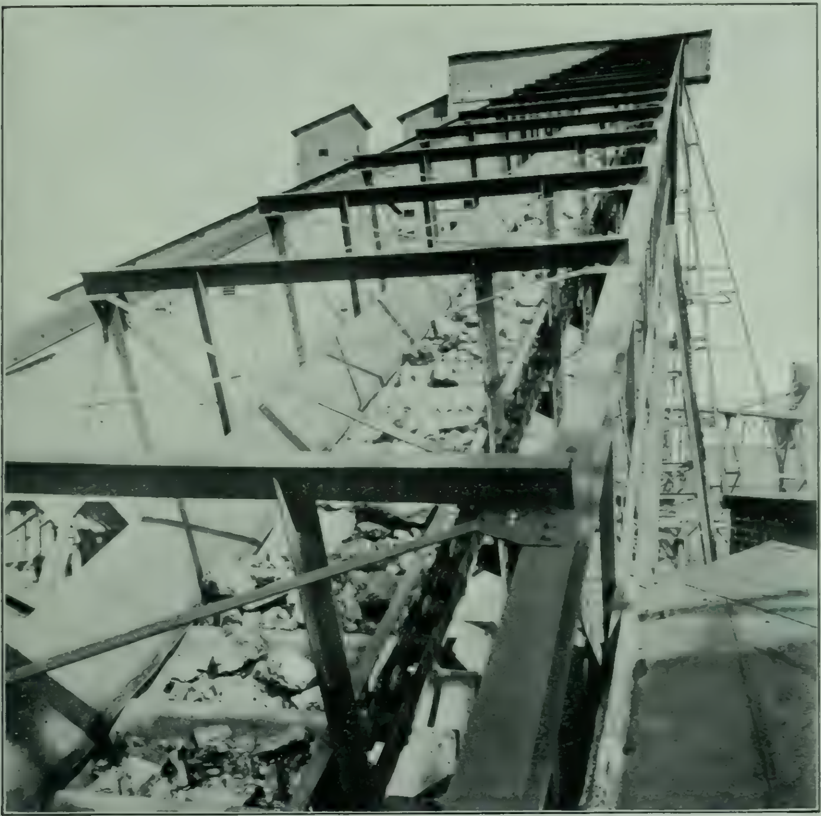

FIG. 8. BUCKET CONVEYOR, PENNSYLVANIA COAL COMPANY'S NO. 14 BREAKER.
This conveyor takes run-of-mine coal from a surface tipple to the head of the breaker. Similar conveyors with chain and scraper flights are in general use for this purpose. Installed by the Link Belt Engineering Co.

runs a chain provided with hooks at intervals; these catch the car axles and carry the cars to the desired elevation, when by the use of a sharp down grade they detach themselves automatically and run by gravity either to the mine opening or, if that is too far distant, to a yard. For any considerable distance beyond the possibilities of gravity handling, perhaps the most satisfactory method is the use of a small locomotive, handling the mine cars in short trains; such "Dinkeys" are usually from 8 to 12-tons weight and from 7-inch to 10-inch cylinder, with four driving wheels, no truck, and saddle tank; the drivers should be quite small, not only for power in starting but to avoid excessive speed which is ruinous to mine-car running gear.

At the breaker, where a hillside to give a level approach is not available, the coal is either dumped at the bottom into large conveyors (Figure 8, just above) or elevators, and thus taken to the top

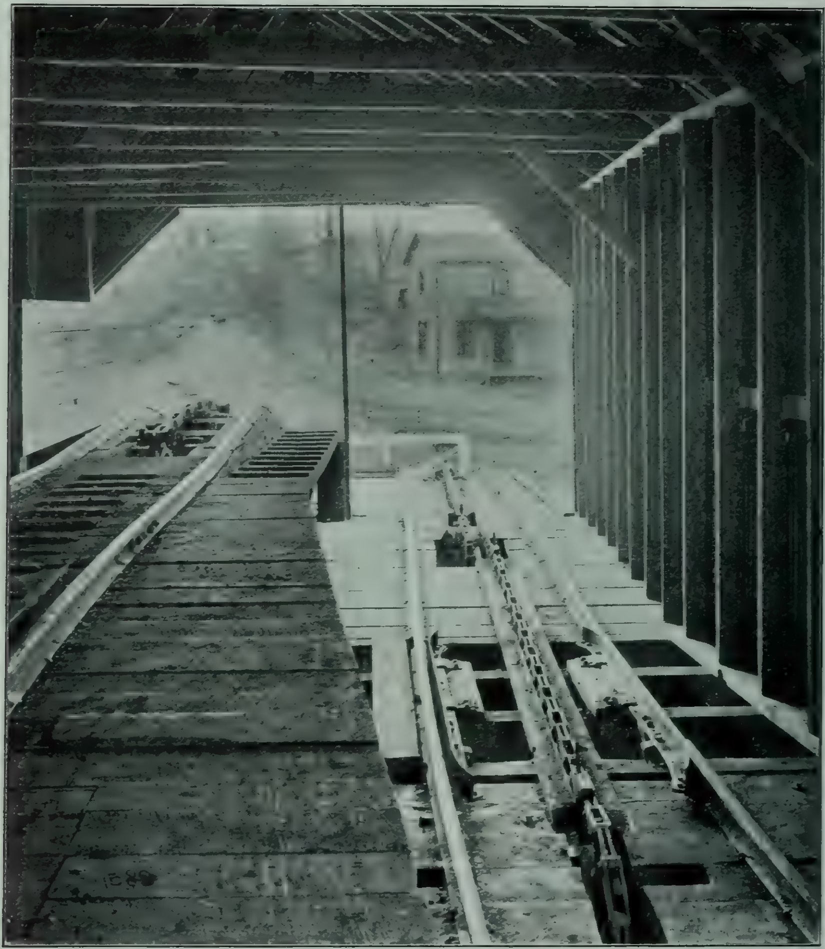

FIG. 9. HEAD OF CAR HOIST, SHOWING FEEDING CHAIN AND TRACK BRAKE.

of the structure, or the cars themselves are hoisted either by dumping cages (Figure 1) or on a plane either by a rope and pusher or by a car hoist (Figure 7). In the latter case the empties are brought down by a separate chain, the hoisting chain having hooks at considerable intervals to avoid overloading, while the lowering chain must have hooks spaced closer than the car lengths so that a car can by no accident miss catching, the upper part of the return chain being in this case on only a very slight grade so that the car may strike the hook without undue shock. A later device is the use of a feeding chain (Figure 9) which delivers the cars properly spaced to the main chain; a similar idea has been used at the foot of loaded planes, the cars being started by a slow chain the hook of which is overtaken at a predetermined point by the hook of the faster main chain; this arrangement, which was first used at the Williamstown breaker of the Summit Branch Mining Co., considerably increases the capacity of a plane without subjecting the car axle to undue shock in picking up the car. It has been found that a speed much over 60 feet per minute for the hook will result in bent axles, while by the use of this starting chain it is possible to speed the main chain to nearly double that velocity, the starting chain at 60 feet picking up the car and the main-chain hook at 120 feet overtaking it and adding another 60 feet to the speed.

In the breaker itself the use of labor-saving devices is the most noticeable. It is necessary in preparing coal to take the rough mine product, containing from 20 to even 50 per cent. of impurities, and consisting of pieces varying in size from lumps weighing nearly a ton to impalpable dust; this material must be accurately sized and cleaned of practically all impurities.

The sizes as prepared for market are

Lump.......	over	6-inch bars.		
Steamer.....	"	3½-inch bars	through	6-inch bars.
or..	"	4½-inch square mesh	through	6-inch bars.
Broken......	"	2¾-inch mesh	through	4½-inch sq. mesh or 3½-inch bars.
Egg.........	"	2 -inch "	"	2¾-inch sq. mesh.
Stove	"	1⅜-inch "	"	2 -inch " "
Nut	"	¾-inch "	"	1⅜-inch " "
Pea	"	½-inch "	"	¾-inch " "
Buckwheat ..	"	¼-inch "	"	½-inch " "
Rice	"	⅛-inch "	"	¼-inch " "
Barley......	"	1/16-inch "	"	⅛-inch " "

The coal as dumped at the breaker first passes over bars with about 6-inch spaces, these being either stationary or of the Coxe oscillating type*, (Figure 10) then over lower steamboat bars with 3½-inch opening; the coal passing over both of these is hand picked, either on a platform, in broad shoots, or on a slow-moving picking belt. Here is separated the heavy slate and bone, many pieces coming from the mines being stratified so that it is necessary to remove the adhering slate from them by hand picks, it being of course most desirable to remove the slate in the largest possible pieces, especially as on the lump size one man will remove from 2 to 3 tons per hour, while in nut size a boy will pick but about 30 pounds of slate in the same time.

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* Trans. A. I. M. E., Vol. XIX, p. 398.

The hand-picking arrangements must be so designed that the coal passes the pickers regularly and with a minimum effort on their part, and yet so that any doubtful piece can be readily stopped for examination or separation. From the bars the lump coal passes to the lump rolls for a first breaking down, and thence after further picking joins the steamboat coal and goes to the second rolls which break it to "broken" size and under.

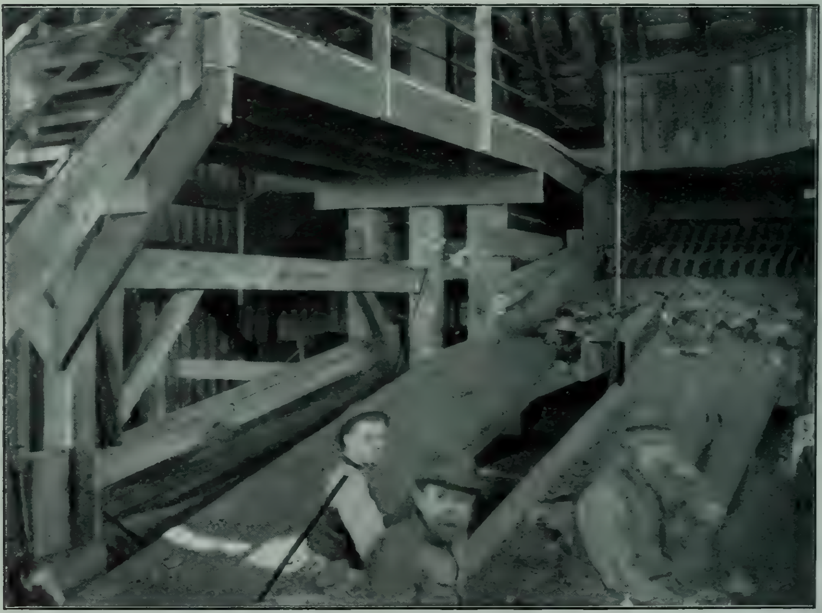


FIG. 10. COXE OSCILLATING LUMP-COAL BARS, IN USE IN WILLIAMSTOWN BREAKER, SUMMIT BRANCH MINING CO.

The breaking rolls (Figure 12) are constructed in the form of toothed cylinders driven together by gearing, the sizes, spacing and forms of teeth being suited to the coal to be broken; while there is a considerable variation in practise as to the teeth the general average would be about as follows:—

Lump rolls	Teeth	4 inches high, 4 to 5-inch centres.
Steamboat rolls	"	3 inches high, 3½ to 4-inch centres.
Broken coal rolls	"	2½ inches high, 2¾ to 3½-inch centres.
Bone rolls	"	1 to 1¼ inches high, 1¼ to 1½-inch centres.

The diameters of the shells vary with the size of coal, later practise tending toward larger rolls of less length; the large shell permits better splitting action of the teeth, while with small diameters there is a tendency for large pieces of coal to revolve and partially disintegrate before passing through.

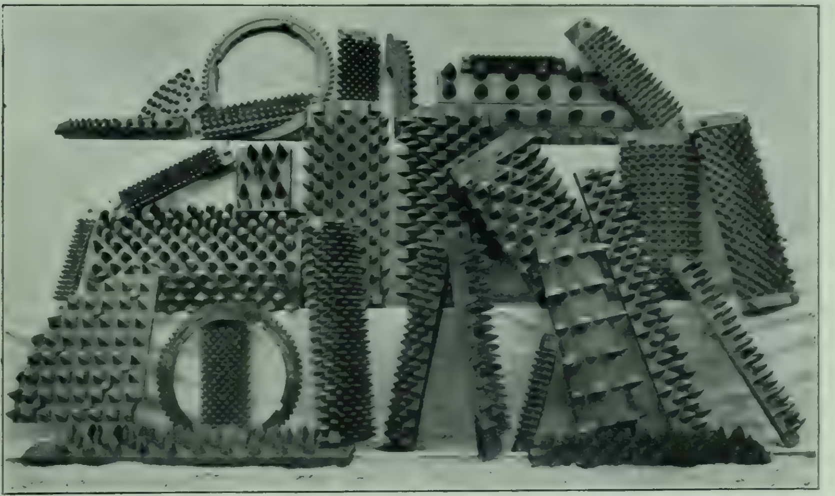


FIG. 11. MANGANESE STEEL SEGMENTS FOR ROLLS, SHOWING VARYING DESIGNS IN SIZE, SHAPE, AND ARRANGEMENT OF TEETH.
The Taylor Iron & Steel Co., High Bridge, N. J.

The earlier roll shells were made of cast iron with cast teeth, the points occasionally chilled; these wore rapidly and had the further disadvantage that a broken tooth or two necessitated the replacement of the entire shell. Such rolls have practically passed out of use, the

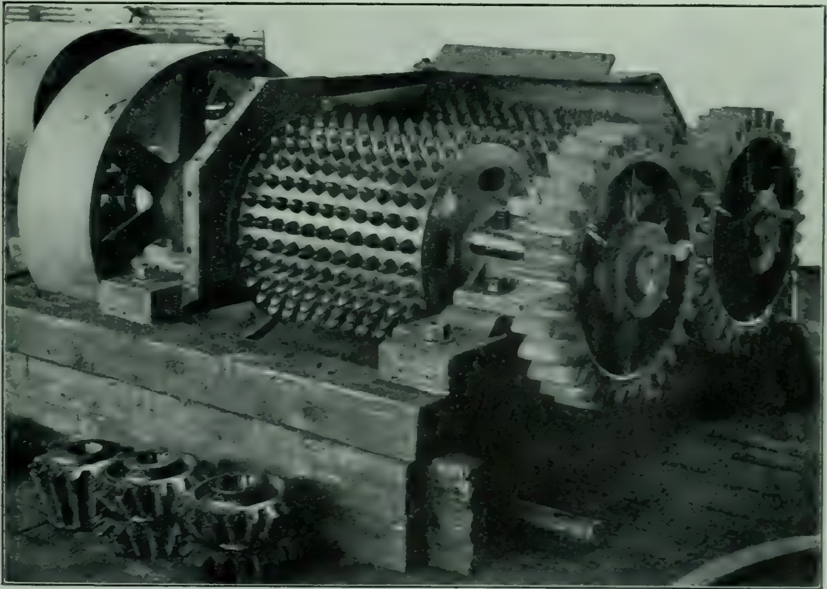


FIG. 12. PREPARED COAL ROLLS.
Built by the Vulcan Iron Works, Wilkes-Barré, Pa.

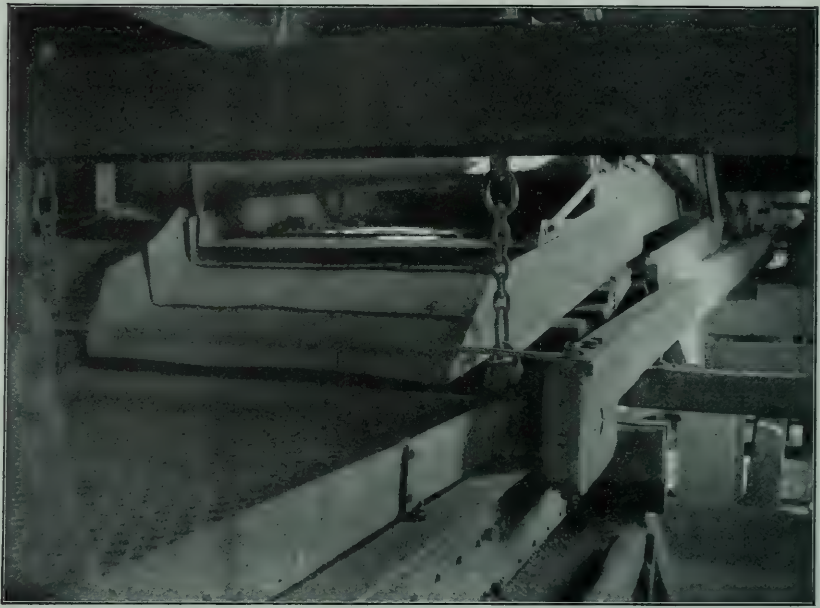


FIG. 13. SHAKING SCREENS INSTALLED IN A BREAKER.
Vulcan Iron Works, Wilkes-Barré, Pa.

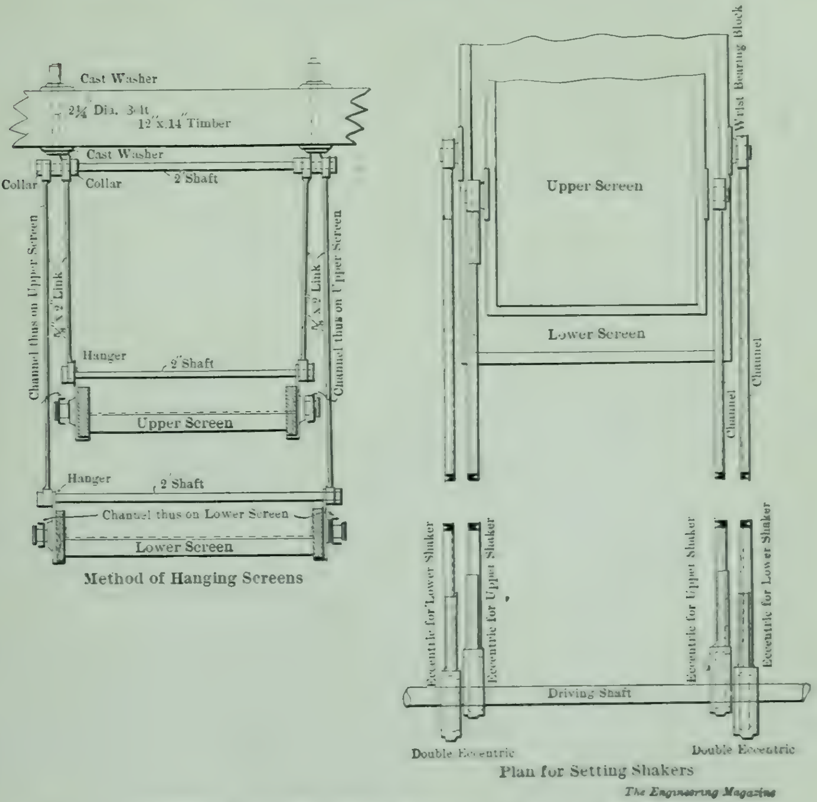
present practise being the use of heavy cast-iron or steel shells with forged-steel teeth driven into reamed holes; these when badly worn are broken off, the stems driven through, and replaced by new teeth. Within the last few years a great many rolls have been constructed of the segmental type with cast manganese-steel segments, either longitudinal or circumferential (Figure 11); these are readily replaced and are coming into very general use, especially for small-size coal where the immense number of teeth—2,100 for a pair of bone rolls 25 by 27 inches—makes the use of inserted steel teeth very costly. The photograph shows well the very varied practise in tooth arrangement and shape, and near the right-hand lower corner the use of large and small teeth in the same roll for lump or steamer coal. Corrugated rolls, invented by the late Eckley B. Coxe, are used to some extent, and appear to be particularly suited for pure coal; these were fully described in the Trans. A. I. M. E., Vol. XIX., p. 398.

From the rolls the coal goes to a series of screens for sizing; these are either round screens, shakers, or gyrators. The earlier practise was to use round screens exclusively, with a few not very successful innovations in the direction of polygonal screens, but within the last ten years practise has been gradually veering to shaking screens

(Figures 13 and 14) to such an extent that for the sizes below stove they are almost exclusively used in modern plants, and are used for all sizes by several of the large companies. Shaking screens, as compared with round, have the advantages of greater capacity, are lower in first cost and probably in repairs, and lend themselves very well to the application of water; they do, however, subject the breaker to considerable vibration, so much so, that it has been found essential to hang them in balanced pairs.

After sizing, the coal still contains large amounts of impurities and it is in the mechanical elimination of these that the greatest advance has been made. While the larger sizes, broken and egg, are usually hand-picked, the greater part of the impurities in the sizes from stove coal down are now removed by mechanical means.

The mechanical pickers may be generally classed as wet and dry.

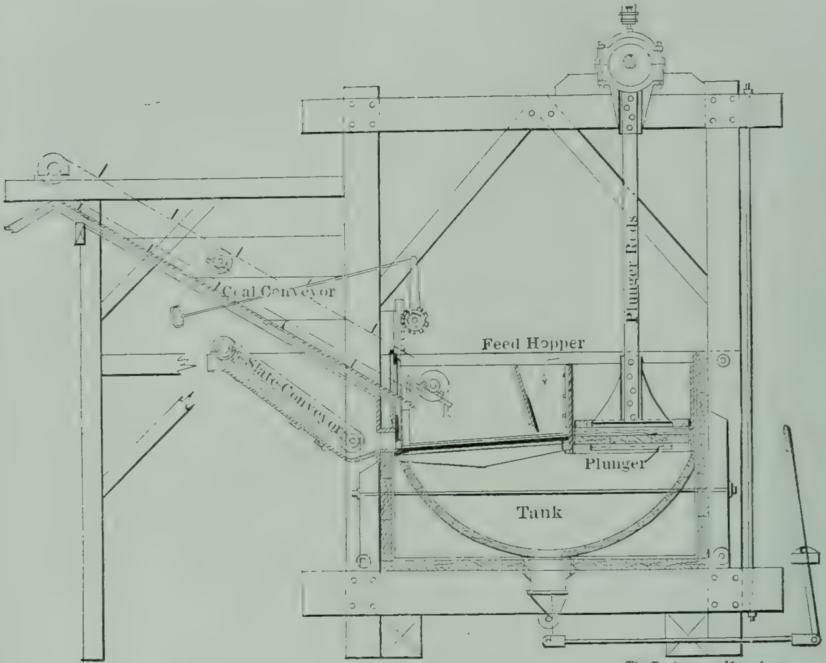


Method of Hanging Screens

Plan for Setting Shakers

The Engineering Magazine

FIG. 14. GENERAL ARRANGEMENT OF SHAKING SCREENS, NO. 7 BREAKER, SUSQUEHANNA COAL CO., NANTICOKE, PA.



The Engineering Magazine

FIG. 15. STANDARD FOUR-FOOT JIG, SUSQUEHANNA COAL CO., MINERAL RAIL ROAD & MINING CO., LYKENS VALLEY COAL CO., SUMMIT BRANCH MINING CO.

the former including the various forms of jigs, of which two general types are in use—plunger jigs (Figure 15) in which the necessary pulsation of the water is accomplished by the use of a reciprocating plunger, the coal and slate layers being removed either by conveyors as shown or by elevators or occasionally by a combination of the two; and pan jigs, in which the pan itself forms the plunger and is churned up and down in a tank of water, the coal and slate discharging into separate hoppers from which they are raised by elevators; these have the advantage of compactness as compared with plunger jigs, but the cost of repairs is liable to be somewhat increased as a result of the reciprocation of the large pan of coal.

The varieties of dry pickers are numerous, each suitable for certain conditions; for the flat slate a simple angle bar with tapered slot (Figure 17) answers admirably; these have large capacity, the Fern picker being said to have a capacity of 4 tons per hour per foot width, and with the drop opening at the end of the bars will also remove a certain amount of heavy rock. Similar slot pickers are often cast cylindrical and attached to the end of round screens with good results. Another type uses a slate table to retard the slate, with a

FIG. 16 JIGS IN COXE BROS. & COMPANY'S BEAVER MEADOW BREAKER.

drop slot to be jumped by the coal, but into which the slower-moving slate falls; of this type the Emery pickers are an example and are largely used in certain districts where the character of the coal is suitable. Another and unique type of dry picker is the the Pardee spiral picker (Figure 18); this consists of sheet-iron or bronze spirals with adjustable pitch, so arranged that by centrifugal force the free running coal is thrown over the edge of the inner spirals and caught in the wide outside casing; the bone runs near the outer edges of the small spirals and is delivered into a separate shoot from the slate, which by reason of its poorer sliding qualities has a tendency to run close to the axis. These for certain coals are very successful, particularly when the mid-product is either run to jigs or to a second spiral; the capacity of each is about 4 to 6 tons per hour, and the separation between coal and slate good; the middle product, however, as noted, is apt to be too rich to throw away, and requires further treatment. The very general employment of these various types of mechanical pickers accounts in a large measure for the reduction in outside labor per ton of production, although the larger sizes are still generally hand-picked

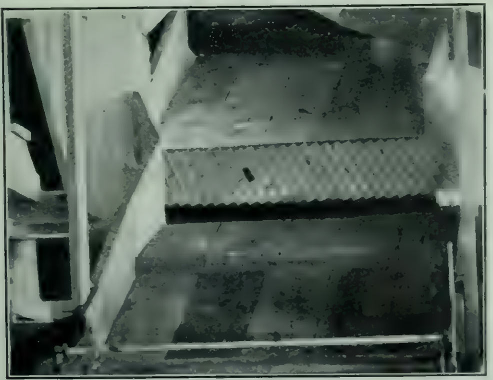


FIG. 17. FERN PATENT ANGLE-BAR SLATE PICKER, FOR FLAT SLATE AND HEAVY WORK.

John Fern & Son, Scranton, Pa.

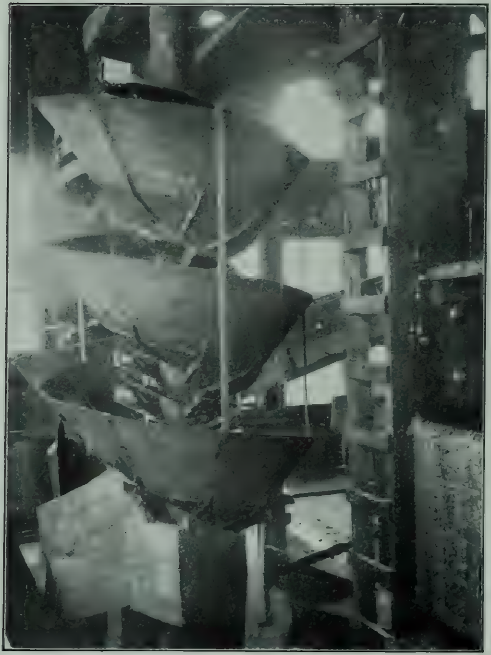


FIG. 18. PARDEE SPIRAL PICKER, IN THE WILLIAM PENN BREAKER, SUSQUEHANNA COAL CO.

This picker makes three separations—coal, slate, and bone—by centrifugal force. Made by Anthracite Separator Co., Hazleton, Pa.

and usually the mechanically prepared coal is given a final hand-picking before going to market. An excellent arrangement of picking shoots is shown (Figure 19), where the coal passing down a central shoot is all drawn off by cross shoots, at each of which a boy is stationed who passes the coal by hand, examining it on the way, into side shoots through which it goes to the pockets.

In steam practise the past twenty years have witnessed not an improvement but a revolution. As late as 1886 there were practically nothing but plain cylinder boilers used in the anthracite region, there being but a very few locomotive and return-tubular boilers and fewer of the water-tube type, while today all the large producers and many of the individuals have changed practically their entire steam plants to either the return-tubular or water-tube types; of the latter the B. & W. and Sterling appear to have the preference, with a number of Hazleton, Clonbrock, Heine, Root, Finger, and similar types, while the return tubulars used are mostly 72-inches diameter by 18 feet long. This change has been brought about principally by the introduction into the market of the steam sizes of coal, which were formerly a waste product, changing a valueless refuse into a material which had to be accounted for; and when it is considered that an ordinary colliery uses about 10 per cent. of its entire output for steam purposes, the necessity for economy in fuel is apparent. The burning of the very fine sizes has brought great changes in grates, greatly increased grate areas, and an increasing use of forced draft. While the old cylinder boilers were usually provided with steam blow-

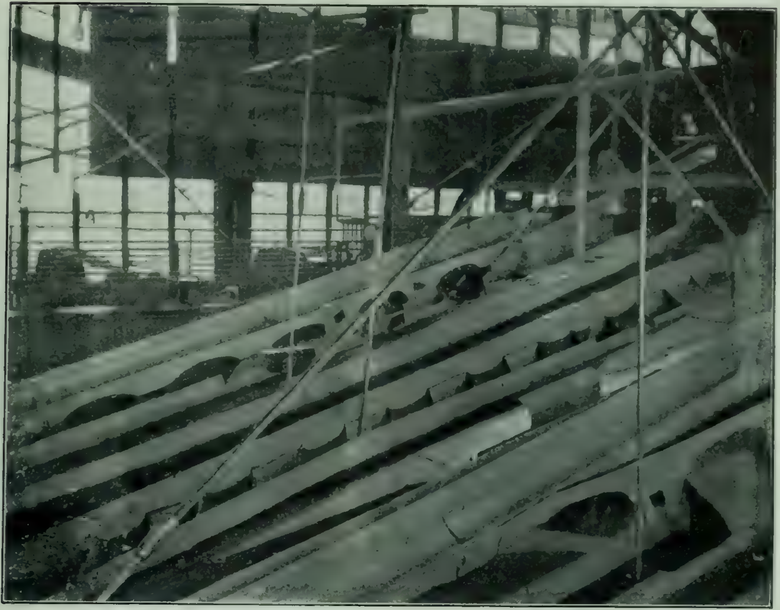


FIG. 19. PREPARED COAL-PICKING SHOOTS, DRIFTON BREAKER, COXE BROS. & CO., INC.

ers, often home-made, which pre-empted from to to 15 per cent. of the total steam, the modern plants have generally improved steam blowers of the McClave or similar types, with a growing tendency to the installation of fan blast; while two or three plants, notably those of the Lehigh Valley Coal Co., at their Packer No. 4, and of the Delaware, Lackawanna & Western R. R. Co. in Keyser Valley, Scranton, are supplied with forced and induced draft and economizers, the latter having also stokers and superheaters. Stokers have thus far been but little used, the plant above mentioned and a few of those of Coxe Bros. & Co., using the Coxe stoker, being the only ones which have come under my observation.

In the good old days any old kind of steam-pipe covering for large pipes, and frequently none at all for small—and even for large ones—was the rule; while at the present time practically all steam pipes are being protected with the best coverings in the market; for the larger ones there is even added an outside inch of hair felt to the usual magnesia or asbestos coverings.

The use of electricity and of compressed air for colliery purposes is rapidly increasing* and it appears to me that the most notable economies in the immediate future are to be looked for in the power plants rather than in the mining or preparation.

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* Trans. A. I. M. E., Vol. XXXIV, p. 512.

COLIATH CRANE HANDLING MATERIAL FROM RAILWAY WAGONS, WALLAROO & MOONTA MINING & SMELTING CO., LTD., AUSTRALIA.

Made by Royce, Ltd., Manchester, England.

LABOUR SAVING IN THE HANDLING OF MATERIALS.

By Arch. J. S. B. Little.

Mr. Little takes up the general application of conveyor systems to industrial and manufacturing plants, extending the use of engineering appliances even outside the field of the strict engineering occupations.—The Editors.

DESPITE the demand for complete efficiency in all that relates to engineering work, the attempts which have been made to apply mechanical means to the transport of materials during process of manufacture have been comparatively few and non-heroic. Nevertheless, it cannot be denied that in most instances where conveyor specialists have been invited to lend their aid, improvements have resulted, and these very frequently after confident predictions of failure by those for whose benefit the work was primarily designed.

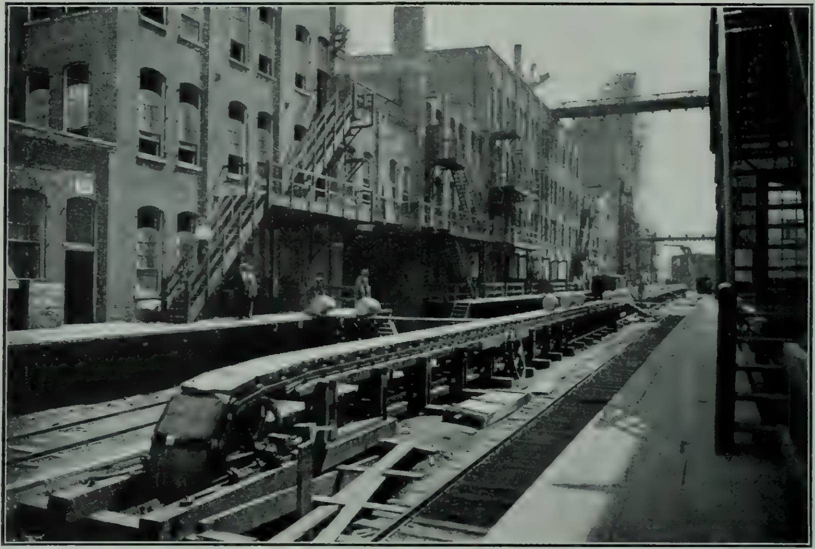
One of the purposes of this article is to show how improved methods have increased the productive power of a given period with a more or less corresponding reduction in human toil; and I propose to deal with plants used in various industries, making the cases brought under observation as divergent as possible, to the end that one or other may appeal to the inquirer, especially in view of the possibility of like methods being applicable to a different, yet in some measure allied, industry.

Little is known of such apparatus employed a hundred years ago. Extant records are most imperfect, and little can be learned from the personal experience of manufacturers. Works were usually small, while means of communication were slow and expensive, and one factory-master would consequently be ignorant of new methods of handling materials in use by his competitor. The few who recognised the importance of the question were no doubt compelled to design the apparatus themselves, aided probably by the maker in the person of a local millwright.

I recently came across a record of the operations carried on at the Soho Foundry by Boulton and Watt, in making the coins for which they became so famous. The writer, evidently a great admirer, referred to the plant of 1788, and, after explaining the (at that time) unheard of speed and accuracy in turning out eighty coins per minute, went on to say that "the sheets, after being laminated and cut in one room, were taken by an endless conveyor to another, in which was situated the press worked by one small boy" *(sic)*.

Some twenty years ago, when the first conveyor company commenced to supply automatic machinery for moving materials, there

PIPE-COOLING CONVEYORS FOR TAKING HOT PIPES FROM THE WELDING MACHINE, SHARON STEEL CO.
Link Belt Engineering Co.



CONVEYOR FOR BARRELS, BAGS, AND MISCELLANEOUS PACKAGES, NEW YORK GLUCOSE CO., EDGEWATER, N. J.

1200-ft. centers, capacity 800 barrels an hour, speed about 40 ft. a minute; reversible drive, operated by alternating-current motor taking about 15 horse power. Built by the Mead-Morrison Mfg. Co., N. Y.

was practically no demand for such appliances, and the designers had, in the first instance, to discover situations where their plant could be advantageously applied, and then to convince the mill owners that by its adoption, the capacity of the works would be increased and the labour-cost reduced. Gradually, however, a demand was created, additional companies were established for manufacturing conveyors, older firms added that branch to their business, and in a few years the whole subject was put on a scientific basis and studied in various offices by independent engineers. Thereafter, the introduction of appliances for transporting materials was exceedingly rapid.

The well-known spiral, or screw, conveyor was brought out in 1890. Its application to modern plants is still extensive, notably for feeding coal to boilers and gas producers. In the plant installed by the Power Gas Corporation at the works of Monks, Hall & Co., of Warrington, coal trucks, carrying 10 tons, are shunted to one end of a row of four Mond-type producers, and are emptied into a hopper with a capacity of, approximately, 450 cubic feet, which has on its underside an automatic agitator and feeder. This unloads the coal gradually from the hopper, being driven by gearing from the elevator, so that any variation in the speed of the buckets is also felt on the feeder, and consequently overloading cannot take place.

Several serviceable patterns of automatic feeders are made by the leading conveyor makers, and one should always be put in under a hopper which feeds an elevator and conveyor, and where coal is dumped by mechanical means. I also advocate the use of a screen of bars, set a few inches apart and fixed over the hopper to keep out large pieces of coal or foreign material which might injure the machinery. In the plant to which reference has been made, the coal is raised by a cased steel bucket elevator to a height of 60 feet and delivered into an 18-inch diameter worm or spiral conveyor, 80 feet long. In the steel trough of this there are, over each hopper, two outlets with controlling doors to allow exit of coal, there being also a hopper over each gas producer. The coal is automatically transported from the trucks, at the rate of 30 tons per hour, to a position

BELL-CONVEYOR SYSTEM, POWER HOUSE OF THE N. Y. INTERBOROUGH COMPANY ("SUBWAY").

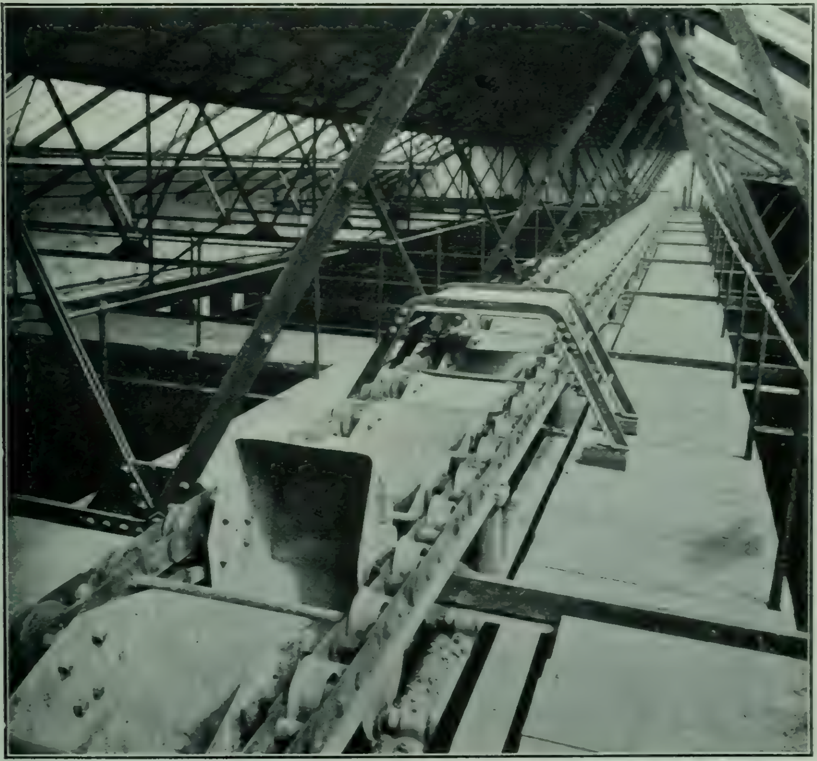
The conveyor from the wharf front is seen on the right; by a series of long zigzag inclined belts, clearly seen crossing the open frame of the structure, the coal is carried to the bins at the top of the station. Robins Conveying Belt Co., N. Y.

suitable for charging the producers. A 6-horse-power electric motor, employed to drive the plant, is situated at the head of the elevator. One man is required for oiling and two others for emptying the trucks. The combined wages should not exceed 1s. 6d. per hour, and, as the plant can raise in that time 30 tons, the labour cost is approximately 2/3 of a penny per ton raised. The cost of machinery, including motor, hopper, elevator and conveyor would be less than £600. This type of plant is manufactured by most of the conveyor makers.

CINDER-HANDLING PLANT, PERKINS & COMPANY'S FURNACES, SHARPSVILLE, PA. The water-granulated slag is handled by a clam-shell bucket, 2 cu. yd. capacity; 40 trips per hour; runway 230 ft. long, covering pit and five gondola cars. Browning Engineering Co., Cleveland, O.

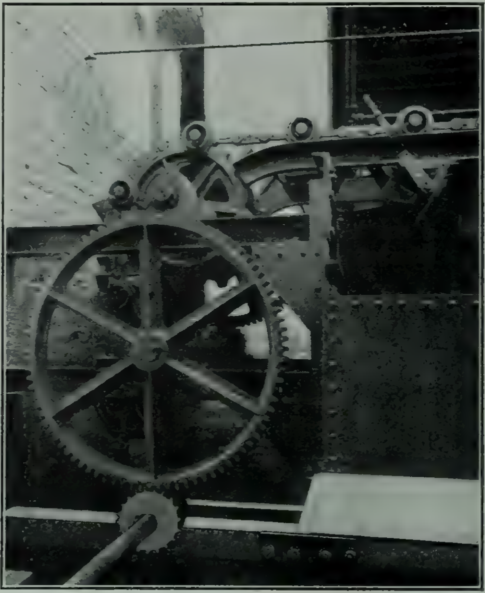
For larger Mond or Duff gas plants, such as those erected, or in contemplation, for generating power gas for distribution to consumers, a different but even more successful style of plant is required, and this generally includes hydraulic rams to tip the trucks, or Hone grabs for unloading the barges; while the conveyors are altered to either the pushplate, or the gravity bucket design. In handling 60 tons per hour, the cost of labour, with a plant of the last named pattern, would be reduced to about 7/16 of a penny per ton, but to secure this low figure, the capital outlay for a plant to deal with six producers is nearly £2,000.

A digression at this point may be excused, in order that consideration may be given to advances which have been made with the gravity bucket conveyor. Among the photographs included in this article will be observed one of this type of conveyor of the usual design, with, however, an improvement in the construction of the buckets and tipping gear, the former being made in one piece instead of in three with riveted joints, and the latter being provided with anti-friction rollers. This conveyor is made by the New Conveyor Co., Ltd., and is in operation at the electric power stations of the Manchester, Sheffield, Newport and Leeds Corporations and of the Mersey Electric Railway. The type made by Graham Morton & Co., Ltd., varies in the chains, these being made of less depth and greater width, without bushes, and with the carrying rollers overhanging. Conveyors of this description have been supplied to the electric power stations at Yoker, Neasden and Motherwell.



GRAVITY BUCKET CONVEYOR, NEWPORT (MON.) TRAMWAY POWER STATION.
Handles coal and ashes; capacity 100 tons an hour, speed 45 ft. per minute. New Conveyor Co., Ltd.

Some months ago, I patented a chain for use on this design of conveyor, which has been adopted in the large power house at Greenwich by Mr. Rider, engineer of the Tramways department of the London County Council.



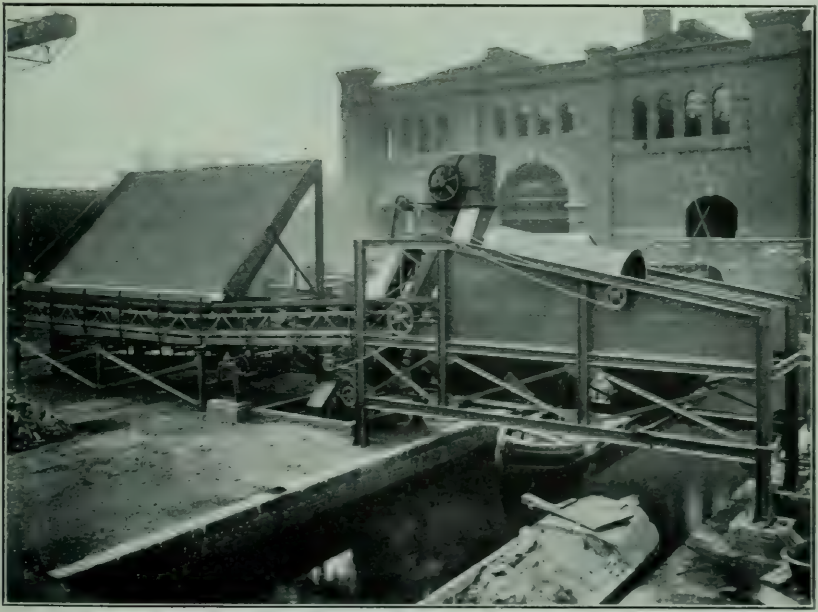
DRIVING GEAR FOR GRAVITY BUCKET CONVEYOR.
Drakes, Ltd., Halifax.

Attempts have been made at various times to design a satisfactory conveyor with overlapping edges on the buckets, and patents, taken out in America by the C. W. Hunt Co., the W. A. Mead Manufacturing Co., and others, have for their object the prevention of spilling of the material and the non-use of the automatic filling device. The difficulty, of course, is to get the buckets to unlock when they alter from a vertical to a horizontal travel. I have found that this can be effected, but at the expense of efficiency and durability, and heretofore it has appeared desirable to remove the attached lips and revert to the ordinary close-butting edges. Quite recently, however, another design has been introduced by R. Dempster & Sons, Ltd., of Elland, with the hope of solving the difficulty.

The feature of this conveyor is the form given to the buckets, of which the bodies are cylindrical and the ends circular, each bucket being provided with two over-lapping lips. A compensating gear of somewhat different design, but to accomplish the same purpose, was invented some years ago by the Link Belt Engineering Co., of Philadelphia, and manufactured in Great Britain by the Chain Belt Engineering Co., of Derby. The chains of Dempster's conveyor differ from those usually employed on gravity bucket conveyors, being made without rollers, these being mounted separately in bearings attached to the framework and made to carry the travelling chains. A working model of this "Tipit" conveyor attracted considerable attention at the International Gas Exhibition held at Earl's Court in November-December last.

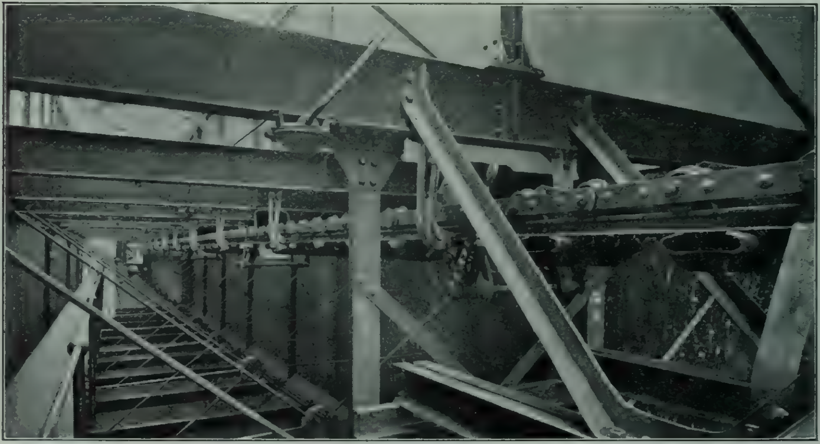
Reverting to the spiral conveyor, I may say that suitable conditions for its introduction exist in dust destructor plants, where paving slabs are manufactured, and the process includes the feeding of clinkers to and from the crushers and granulators into an elevator, which raises the reduced refuse to a pan-mill, into which is also fed the cement in regular pre-arranged proportions. The resulting mixture is then treated in presses. Machinery of this kind is manufactured by Fielding & Platt, Ltd., of Gloucester, and can be seen working at the destructor of the Fulham Borough Council. Spiral scraper, plate, belt, shuttle and other conveyors have also been applied successfully in the manufacture of asphalt, patent fuel, cement, paper, fish-manure, oxide of iron, pens, malt, beer, whiskey, acetylene, gunpowder, matches, salt, glass, etc., all with a saving in the labour item of the wage sheet. By using jacketed troughs and introducing live or exhaust steam, or by building the trough over hot-air flues, these conveyors can be used as drying machines. Mavor and Coulson, Ltd., apply the spiral conveyor to their coal-washing plants, and, where coke ovens are worked in conjunction, the disintegrated coal is similarly conveyed to the charging machine from the large hoppers, which are usually fed by means of aerial ropeways. As a typical instance of this application, mention may be made of the plant designed by Mr. J. H. Darby, and manufactured by the Pearson & Knowles Coal & Iron Co. for the Wigan Coal & Iron Co., Ltd.

Passing to the consideration of other forms of conveyors, I pro-



COKE SCREENING PLANT FOR LOADING BARGES, SALTLEY GAS WORKS, BIRMINGHAM.
Erected by R. Dempster & Sons, Ltd., Elland.

pose, for the sake of contrast, to describe those in use in the large-unit power houses of electric generating stations. Conditions here were so different from anything coming under the every-day notice of the conveyor maker that an application of existing designs was quite out of the question. The gravity bucket conveyor, now used and to which I have already referred, consists of two endless chains made of steel bars about 12-inch pitch with 1-inch joint pins and intermediate roller pins for the driving pawls. The chains are coupled together with 1-inch diameter bars 2-feet pitch, which act as distance pieces, and on the intermediate pins the buckets are hung. These are made to carry, in ordinary work, either 1 or 2 hundredweight of coal, and are mounted on the chains to form a practically continuous row. The chains are provided with 5-inch diameter carrying rollers at 12-inches pitch. As regards the arrangement of the plant, it may be convenient to take the case of a station which receives its fuel in trucks at one end of the boiler house. In England these trucks, holding 10 tons, are shunted over an underground hopper, and on the bottom or side doors being opened, the coal is partly dumped and the balance shovelled out by a labourer. Here is a point which is still open to improvement, for, excepting one instance, the hydraulic tipper usually seen at steel works has not been used at an electric station.



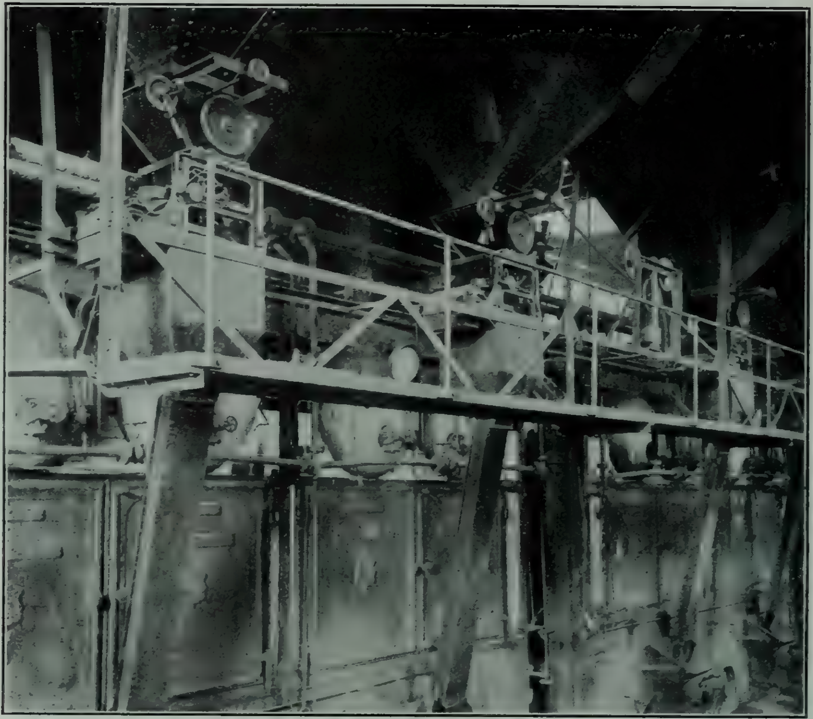
CONVEYOR, OLDHAM ELECTRICITY WORKS, SHOWING RUN OF BUCKETS OVER COAL BUNKERS.
Babcock & Wilcox, Ltd., Renfrew, Scotland.

An arrangement now in operation at the Tramway Station at Newport, Monmouthshire, consists of a vertical cylinder, in which works a ram having at its outer end a V jaw, which, on receiving motion, raises the truck by one axle, using the other as a pivot; on the

COAL-HANDLING PLANT FOR DEALING WITH 60 TONS AN HOUR.
Speed of conveyors 70 ft. per minute; buckets 36 in. wide; each section separately driven by electric motor. The automatic tipper is near the small building in the centre of the yard. Built by the New Conveyor Co., Ltd., on Little's patents, for the Lanarkshire Steel Co., Motherwell.

door at the opposite end of truck being opened, the coal is tipped automatically into the hopper, and time is thus saved in getting trucks ready for removal. Other arrangements worked by direct gear have been manufactured by Ransomes & Rapier, of Ipswich, and West's Gas Improvement Co., Ltd., of Manchester. Where large coal is received, a crusher is placed under the hopper to reduce the coal to a size suitable for the automatic stokers and weighers. The coal from the hopper is fed into the centre of a revolving box, which opens only into the buckets as they pass underneath; consequently the latter are filled without any spill. The conveyor then rises vertically inside the boiler house wall and horizontally over the bunkers, where fixed adjustable or traveling tippers turn the buckets on their own axis through part of a revolution, and upset the coal into the bunkers. The conveyor returns under the boiler-house floor, where a travelling filler receives the ashes through floor shoots and directs them into the buckets, which, in their progress, carry the ashes to a hopper placed at any convenient point in the path of the conveyor. Machine stokers are used on the boilers, and the fuel is fed thereto by automatic registering weighers, so that every section of the transporting and handling plant is self-acting when cared for by two men.

A new form of gravity bucket conveyor, designed by myself, has been adopted at Hull for loading coal to stores. In this case the re-



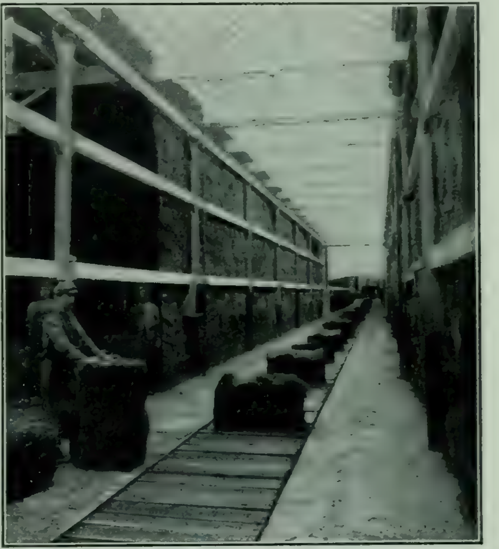
AUTOMATIC COAL WEIGHERS IN CONNECTION WITH CONVEYOR SYSTEM, NEWPORT POWER STATION.

W. & T. Avery, Ltd., Birmingham.

turn strand passes under the stack, in a culvert in the stores, lifting and loading the coal into a separate elevating plant which feeds the overhead hoppers. The same type of conveyor used at the Sculcoates Gas Works in conjunction with the hot-coke conveyors, from which it receives the quenched coke and distributes it over the yard. Again, at the Hanley Gas Works, it puts the coke into stock or feeds it over screens, direct to the railway trucks, while the return strand of the cross-conveyor, which works in a covered tunnel, lifts the coke from the yard and directs it over the screens to the wagons. This is the first time such a conveyor has been used for reloading coke from stock and delivering to consumers' trucks. The improvements on this conveyor are in the construction of the endless chains and buckets, the carrying rollers, also, being provided with means for lubricating the pins while the conveyor is working, the bosses being screwed on the outside and fitted with grease cap.

In all overhead stores where coal is transported mechanically, automatic machines are used to weigh or measure the coal taken out. The general principle of the weighing machine which is applied to boiler houses is too well-known to require detailed description.

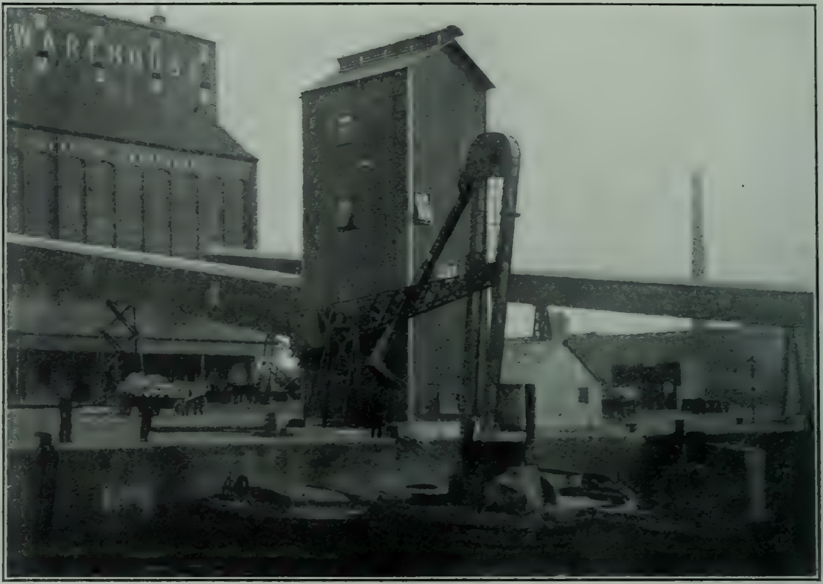
For handling material in bales, bags, packages, or light boxes, a recent type of conveyor, in which a woven-wire band is employed, has been found generally satisfactory. The band woven by N. Greening & Son, of Warrington, has been in use for a number of years at mines for picking conveyors and carriers, but Blake Barclay & Co., of Greenock, were early to see its advantage for the purpose of general conveying. In the first instance, the wire band was supported and driven in the same manner as that adopted on rubber and cotton-band conveyors. A plant was constructed on these lines for Adams Chemical Manure Co., to carry 200-pound bags of chemical manure, with a capacity of 60 tons per hour, over a distance of 400 feet, the conveyor being reversible to take the bags from the wharf to the factory and *vice versa.* On later installations considerable improvements have been introduced by Blake, Barclay & Co., the transporting band being so constructed as to act as a combined elevator and conveyor. This is accomplished by adding cross bars, which are attached to the wire band, and have their ends formed to act as spindles, on which run rollers to carry the band. Thus the friction is considerably reduced, as compared with the old method of using carrying rollers independent of the band and revolving in bearings attached to the framework.



HAY CONVEYOR, MIDLAND RAILWAYS PROVENDER STORES AT OAKHAM.

Designed and installed by Spencer & Co., Ltd., Melksham.

Another form of conveyor used for packages is the cotton-band type, which finds special favour in flour stores. Henry Leetham & Sons, of York, use it for conveying full bags of flour and offal, from one end of the store to the other, for loading into railway wagons. These conveyors, of which there are two, are about 300 feet long, and the sacks, weighing 280 pounds each, are fed onto the conveyor, down a shoot sufficiently rapidly to load twelve railway wagons per hour. At the delivery end there are two lines of rails, and while one wagon is being loaded a full one can be drawn out, from the other siding, and an empty one substituted. This plant was installed by Spencer & Co., Melksham. In other pages will be found illustrations of some very interesting installations, all electrically-driven, for which this firm is responsible. Among these, special mention may be made of the grain discharging elevator recently erected at Leith Docks.



SELF-BALANCED BARGE ELEVATOR, LEITH DOCKS.

The grain is discharged from the barges, weighed in 5-ton lots in a weighing machine, and passed through a gantry band conveyor to silo ware house. Capacity 120 tons an hour. Spencer & Co., Ltd., Melksham. A larger elevator, serving ocean-going vessels, has a capacity of 350 tons an hour. All the machinery is under control of the operator in the tower.

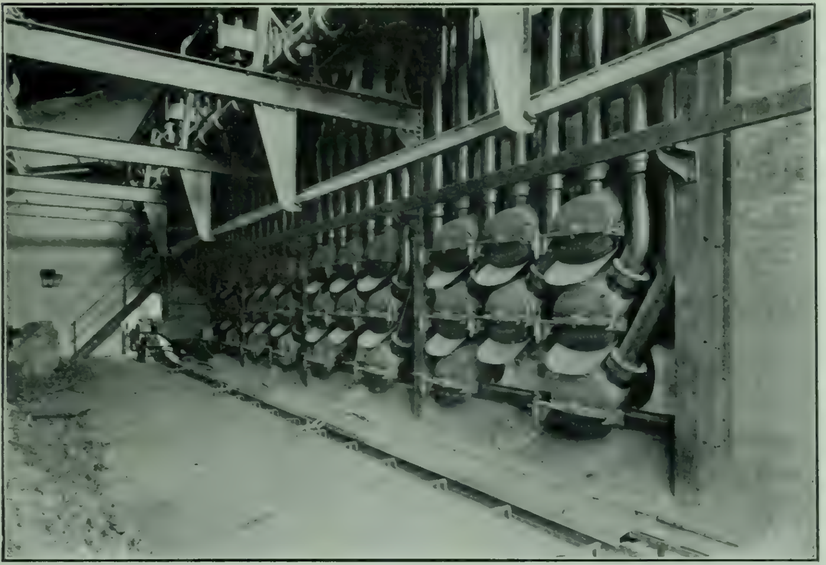
Some years ago the Robins belt conveyor was introduced into mines by an American company, who gave a great deal of attention to the materials and construction of the belt and concomitant parts. The former is built up with a woven cotton belt as a foundation, this being made thin in the middle portion, and then rubber is added to fill the interstices and cover the cotton. The result is a belt of great strength, presenting a surface of rubber; and, owing to the thinness of the cotton in the centre, the belt is very flexible, and can be curved by using triple idler rollers with the outside ones set on an incline. It is thus possible to get a large load on the belt and run it at speeds up to 600 feet per minute without fear of spilling. This conveyor is simple in design, takes little power to drive, and has a long life, with little expense, even when dealing with gritty materials such as the rock, ore and tailings at gold mines. It is used for handling coke at the gas works, Everett, Mass., conveying a distance of 200 feet up an incline of 21 degrees at the rate of 200 tons per hour, with a belt speed of 500 feet per minute. At the Pennsylvania Coal Co., Pittston, culm is fed to a movable hopper by means of a steam shovel, and even delivery is ensured to the screens at the washery. As the heap recedes, the railroad carrying the steam shovel is shifted and the conveyor moved bodily, sideways, close to the bank. These conveyors are 24 inches wide, 250 feet long each, speed 600 feet per minute and capacity 250 tons per hour. The trippers used on these belts, for discharging the load at intermediate points, can be made self-moving. These trippers are mounted on rails and have two pulleys which make the belt take the form of an S, and as they have opposite directions of rotation, power can be applied to drive the carrying wheels, from either of the pulleys, by use of spur and worm gearing. The reversal of the tripper at each end of its run can be made automatic, by means of levers carrying a falling weight, which reverses the train of gears.

RUBBER BELT CONVEYOR AND MOVABLE THROW-OFF CARRIAGE FOR DISCHARGING INTO ANY BIN.

Graham, Morton & Co., Leeds.

Passing to the use of conveying appliances at blast furnaces, it may be remarked that some means of reducing manufacturing costs has long been needed. The hoisting arrangements for the ore and stone have, from time to time, been fully explained by contributors to this Magazine, but to my mind the mechanical means for making and loading pigs after the metal leaves the furnace deserve greater prominence than has generally been given to them. The Uehling casting machine (described elsewhere in this issue by Mr. Hatch), as is well-known, consists essentially of a very strongly built conveyor, the overlapping "buckets" of which are pig-iron moulds; these are passed in endless procession under the pouring spout, through a proper distance of cooling travel, and dumped into a tank where the solidified pigs are taken in turn by a plate conveyor to loading or storage. The significant point is not merely the cheapening of labour costs, but the complete removal of the limits to blast-furnace production which formerly lay in the limited capacity of the sand bed. The first successful Uehling plant in Great Britain was put down a year or more ago, at the works of Bolckow, Vaughan & Co., Middlesbrough, and has a capacity of 1,200 tons a day.

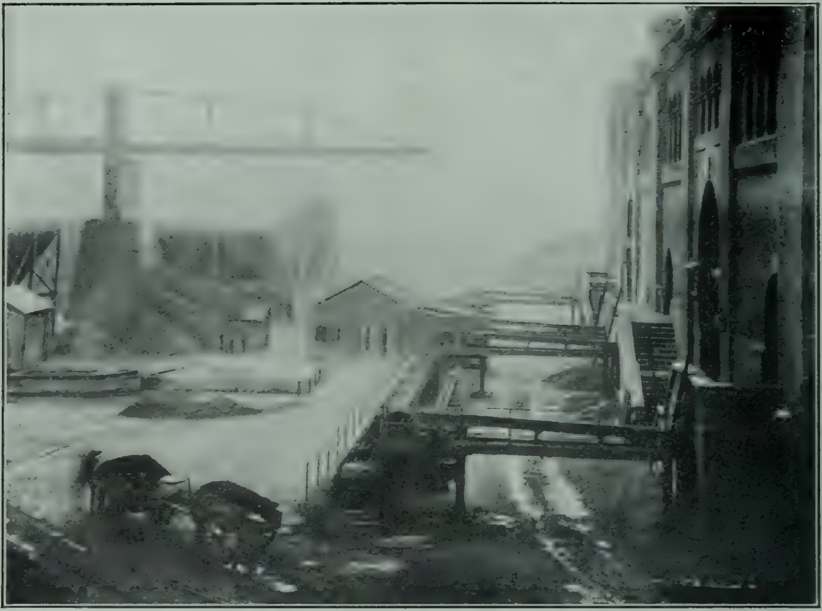
PART OF THE COAL AND ASH-CONVEYING PLANT, FRICKLEY COLLIERY OF THE CARLTON MAIN COLLIERY CO., LTD.
Installed by Ed. Bennis & Co., Little Hutton, Bolton.



RETORT BENCH AND HOT-COKE CONVEYOR IN A MODERN GAS WORKS.
The discharging end of inclined retorts, Shrewsbury Gas Works. The coke slides out when the retort doors are opened and is carried away by the conveyor. Erected by R. Dempster & Sons, Ltd., on Broadhead's patents.

In dealing with the coke pushed out by ram from coking ovens, and transporting it to trucks, what used to be a difficulty has, after much experiment, at length been overcome. I refer to the excessive wear and tear, not to speak of breakdowns, inseparable from the conveyors at first used. These, more often than not, were designed with insufficient regard for the difficulties consequent upon handling material possessing the wearing properties of either metallurgic or gas coke. Some years ago, Mr. Forgie, of William Baird and Company, took the matter in hand and designed a conveyor which Kesson & Campbell made for his company. This consisted of a traveling tray belt of iron plates, mounted on a single chain of massive proportions, to which were attached, at about 3-feet pitch, spindles for receiving at each end the rollers for carrying the moving trays. These ran on ordinary rail metals, of which there were four strands. The return belt passed underneath the loaded one, and between the two there was an obliquely set plate for directing, to the side of conveyor, the surplus water used in quenching the coke as it travelled on the conveyor to the railway trucks.

Steel-works managers, generally speaking, appear to be convinced that the wear on conveyors handling coke is so great that these mechanical appliances are not suited to the purpose. Such doubts indicate absence of study of the latest practice in gas works. There is, as a matter of fact, scarcely a gas works of any consequence where coke conveyors are not used for dealing with the products of partial distillation from the retorts, and the patents concerning such conveyors taken out during the last ten years would cover pages of the Patent-Office journal. The conditions at gas works are more arduous and exacting than at coke ovens, for the work is practically continuous, and as the coke must be removed in a hot state the conveyor must do this without reducing the size or making breeze.

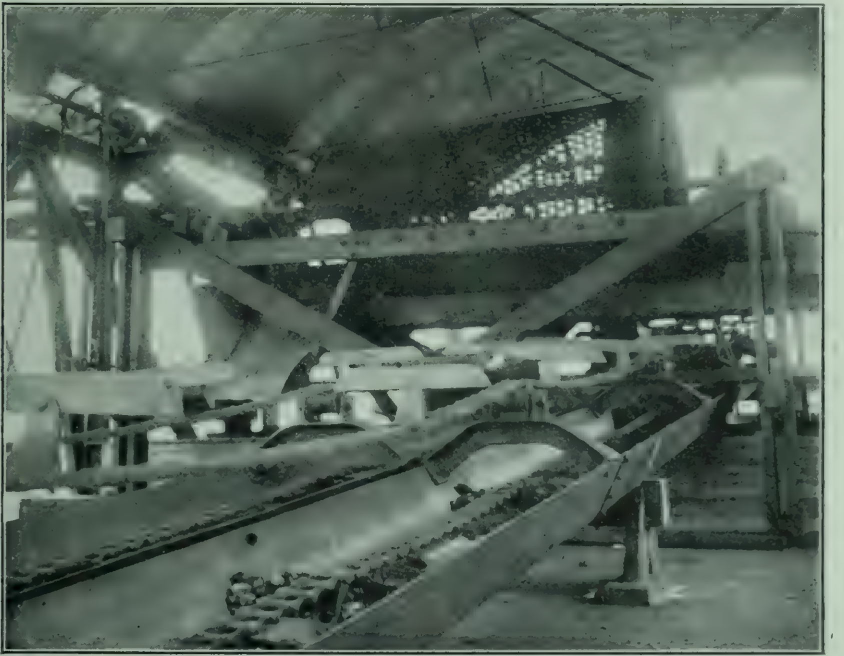


FOUR HOT-COKE CONVEYORS AND ONE CROSS CONVEYOR FOR FEEDING CRANE, BIRMINGHAM GAS WORKS.

The crane dumps onto bar screens for loading the coke into trucks or barges. Little's patents.

British gas works are certainly far ahead of those of any other country in the application of mechanical transport appliances, and it is interesting to note that Mr. W. H. Bradley, of the Consolidated Gas Co., of New York, after a trip round the world, decided to follow British methods on his new works at Long Island, where inclined retorts are now being built. Retorts on this principle are set at an angle of 32 degrees, and are charged by gravity from measuring or weighing boxes, situated under longtitudinal coal hoppers, fed by conveyors receiving coal from stores through the elevator. When the gas in extracted, the door on the lower end of the retort is opened and the coke slides out into the conveyors.

Another good example of conveying machines is found in the application of an endless steel-tray conveyor in a machine shop, for the purpose of transferring the chips and cuttings from machine tools to the scrap heap. There is no limit to the length of such a conveyor or the number of machines it will serve; and the taking away of the scrap can be continuous or intermittent, as may be found more suitable. The principle can be applied to the handling of the products as well as the refuse, provided there is a sufficient number of machines at work on one article; and if there is a large number of these automatics in operation on, say, six different sizes or shapes, it is not difficult to arrange for each article being kept separate on the conveyor and at the point of discharge. These steel-tray conveyors are often used to transport coke to the producers in a water-gas house and generally for handling any gritty or viscous material. At chemical works, large pieces of phosphate rock are first unloaded into elevators and afterwards distributed to the large stores, a good example of this kind of plant being at the Wigg Works of the United Alkali Company. Here also there are additional conveyors and elevators for feeding the rock from stores to crushers, screens, etc., thus dispensing with barrows, hoists, and the army of labourers formerly required.



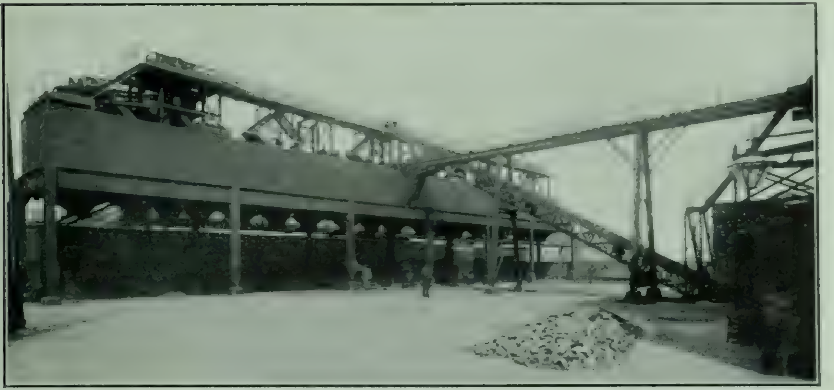
INTERIOR OF A COKE WASHERY INSTALLED BY THE HARDY PATENT PICK CO., LTD., SHEFFIELD.

Ropeways form an entirely different class of transporter to the endless-chain conveyors previously dealt with, and their province is with outside and long-distance operations, rather than in workshops and warehouses.

Valuable as conveyors are as a means of saving labour, it must be remembered that the usefulness of these appliances does not end at this point. There are many cases where other important considerations arise, such, for instance, as the necessity for rapidity in handling, in order to keep the output sufficiently high, and the fixed dead charges per ton low. Then, again, where labourers are scarce or unsatisfactory much may be done to relieve the situation by putting down conveyors. To cite another instance, there are many kinds of machines which require provision for dealing with large quantities of material, in continuous loads over a long period. Take a crusher, tube-mill, stamp, or grinding-mill plant. Each crusher may have a capacity so great that hand labour, or mechanical appliances handling large loads irregularly, prove utterly inadequate for feeding. For this relief may be found in the adoption of a mechanical method of transport, which embodies the principle of continuous supply of small quantities at high speed, and this can be applied both for feeding to and removing from the machines. Perhaps of even greater benefit is the spreading of work over a long period, in order to get

DOUBLE-STRAND ROLLER-TYPE CONVEYOR, 140 FEET LONG, 15 INCHES WIDE, 30 TONS PER HOUR CAPACITY.

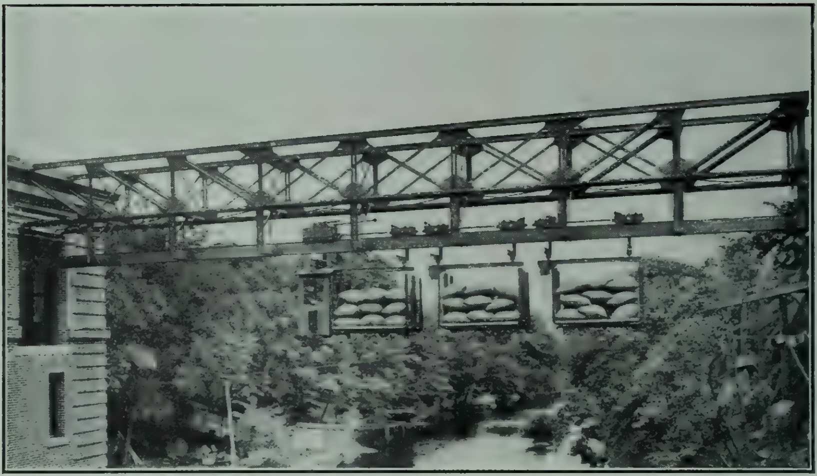
By Blake, Barclay & Co., Greenock.



COKE CONVEYOR WITH SCREENING, SORTING, AND RAILWAY-WAGON LOADING PLANT. Installed on the De Brouwer patents at Albion St. Gas Works, Salford, by W. J. Jenkins & Co., Ltd., Retford.

accumulated power from small machines. This is found practicable in loading hoppers which require to be quickly emptied at stated periods, and as an example we may take a plant for loading minerals or materials into ships where expedition is required, as in fact on a tidal river where the difference in levels precludes vessels from approaching the wharf except at high-water time. A small plant working over the twelve hours would put into the hopper sufficient material to fill a large hold, and on a wide river or flat coast the ships could be loaded and sent off on the same tide on which they came in.

A ROPEWAY FOR CARRYING "PADDY," AT WORK IN CHINA.
Length 620 ft.; capacity 30 tons or 420 bags of paddy per hour; twelve ropeway grips; lattice steel towers 35, 32 and 25 ft. high; 4½ by 10 in. horizontal engine for driving. John M. Henderson & Co., Aberdeen.

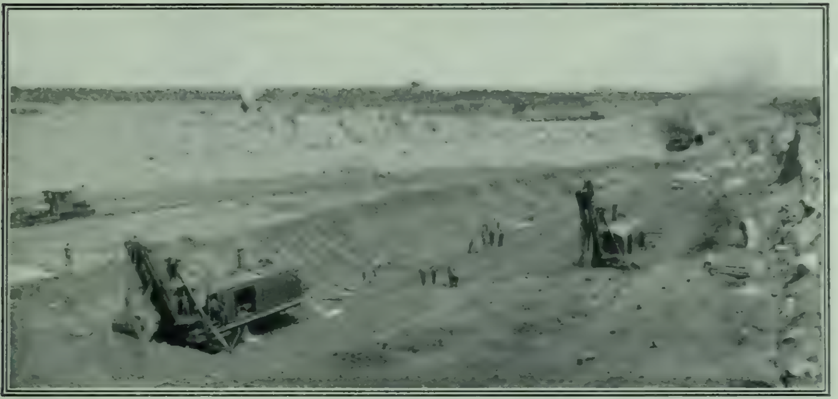


TELPHERAGE SYSTEM, WALTER BAKER CHOCOLATE WORKS.
The line runs from the freight station along a river and into the mill. The telpher and two trailers handle bags of cocoa. United Telpherage Co.

The employment of labour-saving machinery will, in my opinion, become more and more general as manufacturers popularise the knowledge of its usefulness. Conveyor makers, heretofore, have surrounded their industry with artificial difficulties, forgetful of the fact that, advantageous as it may seem to keep secret from would-be competitors the result of accumulated experience, there is greater danger to themselves in leaving in ignorance the prospective purchasers.

Daniel Webster, lecturing in 1828 on the progress of the mechanical arts, eulogised the power of machinery in general, but in a manner which unconsciously particularised transport appliances. Although realising the illimitable possibilities discoverable by man, through the progressive improvement of his faculties, Webster could not "pierce the shades of dim futurity" and forecast the benefits beyond human measurement, which would result, in the short compass of a century, from human sagacity, stimulated by human wants, seizing on the natural assistance of mechanical power. Yet even in his day it was possible to draw a word picture such as this:—

> "Machinery is made to perform what has formerly been the toil of human hands, to an extent that astonishes the most sanguine, with a degree of power to which no number of human arms is equal, and with such precision and exactness as almost to suggest the motion of reason and intelligence in the machines themselves. It is on the rivers, it is on the highways, and exerts itself along the courses of land conveyance; it is at the bottom of mines, it is in the mill and in the workshops of the trades. It excavates, it carries, it draws, it lifts. It seems to say to man—'Leave off your manual labour, give over your bodily toil; bestow but your skill and reason to the direction of my power, and I will bear the toil.'"



Marion Steam Shovels at Work in Burt Mine, Kibling, Minn.

MECHANICAL HANDLING IN THE MANUFACTURE OF IRON AND STEEL.

By James N. Hatch.

It was pointed out in the introduction to Mr. Norris' article that any economies in the production of coal must ultimately be reflected in the reduction of all power costs based upon coal-using. So any economies in the manufacture of iron and steel must affect the material cost of almost all engineering construction, for these are the almost universal structural materials of the day. And as a concrete demonstration of labor-saving appliances in mining and mechanical transport, Mr. Hatch's subject affords the most majestic and impressive examples to be found in the world.—The Editors.

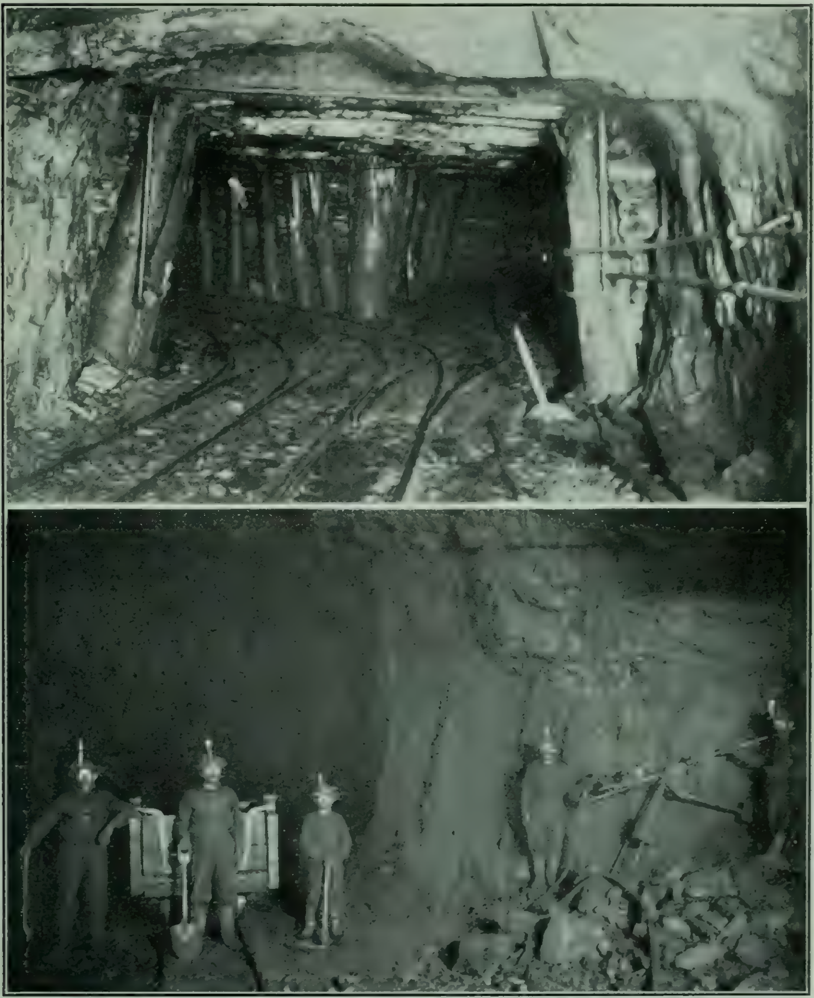
THE steel industry in the United States, which has now become so gigantic that national prosperity seems to be in a large measure dependent upon it, has had its birth and growth in the last forty years. Yet so great and so rapid has been this growth that the annual consumption of the country is now nearly 10,000,000 tons—an amount which, if rolled into a single 50-pound railroad rail, would make a rail long enough to reach from Pittsburg to the moon, or enough for a railroad track to the moon every second year.

To gather together the ingredients and to manufacture this amount of steel is an enterprise of such gigantic proportions as to be almost beyond comprehension. And when is added to this the distribution of the finished material over the entire civilized world, the fabulous stories of the "Arabian Nights" fade into insignificance. The ingredients used for making all of the iron and steel used in the United States each year will easily aggregate 80,000,000 tons. These ingredients are moved on an average of 400 or 500 miles. This means that if the whole population of the United States were set at the task by hand labor, each individual would have to transport one ton of material 400 or 500 miles per year, or over a mile per day, to do his part in collecting the ingredients for supplying the nation's iron and steel. This exemplifies what an enormous part machinery must play in this enterprise.

An article on the subject of steel making in the United States naturally divides itself into three somewhat distinct parts; (1) the mining of the ore; (2) the transportation to the furnaces, and (3) the convertion of the ore into steel. A detailed account of the various processes used in any one of these branches would lead far beyond the scope of a magazine article, so only some of the more conspicuous points can be touched upon, such as will best connect the various links of a somewhat roughly forged chain of events through which our iron ore must pass.

The Lake Superior region really became a factor in the iron business in 1856, when the through shipment of ore by lake was begun. The few thousand tons that had been mined in that region prior to that were hardly significant, compared with later figures. At that time the annual consumption of domestic iron ore in the United States was about 1,600,000 tons, derived principally from Pennsylvania. Prior to 1854 it is estimated there had been taken from Lake Superior mines about 75,000 tons of ore, the product having been worked up into pig iron in the old charcoal furnaces and catalan forges near the mines. A trial lot of ore had been sent to Pittsburg and another lot to New Castle a year or so earlier than this, but the portage around the Sault Ste. Marie Falls (which required loading and unloading several times) made the freight rates so excessive as to discourage the movement in large quantities. In the summer of 1855 the first locks of the Sault were completed, and the movement of ore from the Lake Superior mines to the Lake Erie docks began in real earnest. The year 1856 really marks the beginning of the line of lake shipment, and the output from the Superior region, which was then confined to the Marquette Range, was for that year 6,790 tons. The ore was transported from the mines to the docks by teams of mules over the new plank road which had been completed the previous year.

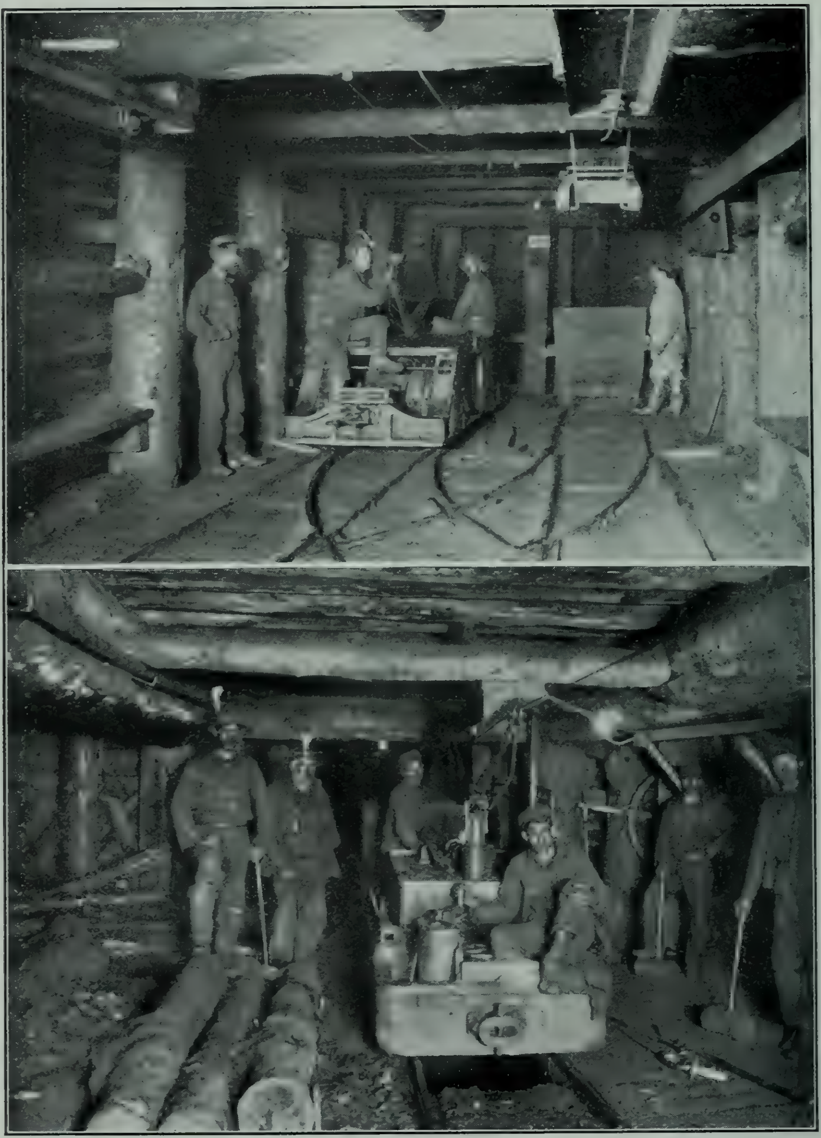
At that time only deep mining in hard ore was carried on, and only the crudest machinery was employed. The soft hematite ores which were found upon the surface of the ground were supposed to be valueless. A shaft was sunk through the top earth till the vein of ore was struck, or the ore was reached by horizontal drifts. The ore was loosened up with picks and shovel, thrown into buckets, and



UNDERGROUND WORK IN LAKE SUPERIOR IRON MINES.
The lower view is in a hard-ore mine—the Cliff shaft of the Cleveland Cliffs Iron Co. The upper one is in a soft-ore mine.

hoisted to the surface by windlasses turned by hand, or with the use of horse whims. On the horizontal drifts carts and wheelbarrows were used to bring the ore to the surface. In 1857 the first railroad for carrying ore was completed from Marquette to the adjacent mines, and the output was quadrupled.

Power drills driven by steam or compressed air were introduced in 1878, and the use of tram cars was begun in 1880. Since then the improvement of mining machinery and the invention of more effective explosives has kept pace with the other improvements. As the im-



ELECTRIC HAULAGE IN THE LAKE SUPERIOR IRON MINES.
The upper picture is taken in the Lake Angeline Mines; the lower is in the Cleveland Cliff mines, near Ishpeming, Mich.

provement in machinery has moved up the cost of ore production has moved down, so that now ore can be produced at the mouth of the mine ready for shipment at 70 cents per ton, where it would have cost $3.00 or $4.00 per ton fifty years ago. The use of electric, hydraulic, and pneumatic machinery, of cable and electric tramways and hoists, has so far improved conditions that one man will now do the work that formerly would have required a score or more.

Mining is carried on in the Superior region under two general systems—surface mining and deep mining—somewhat more than one half of the output still being taken from shafts sunk to a depth of 1,000 or 1,500 feet.

The modern methods of deep mining have been attained by gradual stages; but in surface mining, the use of the steam shovel by which nearly one-half of the output of the Superior region is now obtained has sprung up as if in a day. A steam shovel taking up 5 or 6 tons at each scoop can be operated with three or four men, and will mine and load 5,000 or 6,000 tons of ore per day, or about 150 to 200 carloads. Hand shoveling of the same amount of ore would require the services of 75 to 100 men. As fast as the cars are loaded they are drawn out of the ore pit and made up into trains of 40 or 50 cars each, ready to be taken to the ore dock.

1860	1875	1888	1890	1895	1900
6 tons	20 tons	25 tons	30 tons	40 tons	50 tons

THE EVOLUTION OF THE ORE AND COAL CAR.

Some idea of the magnitude of the iron-ore mining industry in the Superior region may be gained from the fact that the annual excavation of ore, not including the refuse incidentally removed in stripping, is equivalent to 50 acres dug to the depth of 100 feet. When loaded on cars it represents a train 5,000 miles long. The illustrations show some of the great craters left where mining has been carried on.

When the ore has been mined and loaded on the cars it is ready to start on its journey of 1,000 miles or more across land and sea to the furnaces. The first link in this chain is the ore-carrying train from the mines to the ore docks. The distance varies from only a few miles to something over 100 miles. The great locomotives that haul these long trains of ore cars are ponderous machines and have played an important part in ore transportation, but do not differ widely from hundreds of others. The unloading of these trains at the docks, however, offers some novel features. The railway tracks from the mines lead out upon the storage docks into which the ore is to be dumped. Each car is first stopped upon a track scale and the weight of the cargo obtained. The train is then hauled out upon the docks, and stopped over the ore pockets. Here the bottom of the car is opened. At this point, however, a strange thing occurs. The ore although permitted to run out, does not do so. The fact is that after the ore has been jolted down by its ride from the mines, it packs in the car so tight that it is only by much prodding and punching, requiring the work of a dozen men ten or fifteen minutes, that it can be induced to flow out through the open bottom of the car. In this respect the ore docks are not up to date, as the cars could be unloaded much more rapidly and at considerably less cost by a car-unloading machine such as will be shown further on.

There are at various harbors along Lake Superior and Lake Michigan between twenty-five and thirty of these ore docks, with an aggregate length of nearly six miles and a total storage capacity of nearly 1,000,000 tons. Some single docks are over 2,000 feet long and can accommodate four or five vessels at a time. The total cost of construction has been over $7,000,000. At first thought it might seem that the interest on the great cost of these docks would go far toward offsetting the possible saving; but when it is remembered that with these improved methods a dozen vessels can load and a dozen trains unload in the same space and in the same time required for one under the old *règime,* it will readily be seen that there is actually a saving per ton of ore moved.

The loading of an 800-ton vessel of the 50's was a stupendous task, and the hand shoveling, wheel-barrow movement, and hand dumping, cost not less than 40 cents a ton. At the present time, the ore could be mined, transported to the dock, and loaded, for little more than that. It is a very common thing for a 6,000 or 7,000-ton vessel to load at one of these modern docks in two or three hours. The dock at Duluth, of the Duluth, Missabi and Northern Railway Company, made a loading record in June, 1901, which had never before been approached on the lakes—64,000 tons of ore in 24 hours, loaded into fourteen large vessels of about 4,500 gross tons cargo.. This would be equivalent to a season's movement of 13,000,000 tons. During the present summer the Augustus B. Wolvin, the largest boat on the

CONNEAUT DOCKS; SHOWING ORE VESSELS CROWDED IN, WAITING TO BE UNLOADED.

lakes, was loaded from the Great Northern Railway dock at Allouez according to the following schedule:—

Boat arrived at dock	2:45 P. M.
Started to load	4:16 "
Finished loading 9,000 tons	4:50 "
Shifted to complete cargo	45 minutes.
Loaded complete (12,245 tons)	5:45 P. M.
Total time at dock	3 hours.
Total time loading	1 hr. 29 min.

These figures are of course record-breaking, but serve well to show the possibilities.

There are at present several hundred ore-carrying vessels on the Great Lakes, capable of moving during the season of open navigation fully 30,000,000 tons of ore. The vessels vary in carrying capacity from 2,000 to 12,500 tons burden. It hardly need be explained that the smaller ones are in most instances those of the older type which are not yet worn out. The 12,500-ton vessel represents the latest type of ore carrier. They are 550 feet in length and of about 15,000-tons displacement. These vessels are made entirely of steel, and have a horizontal steel floor near the bottom, on which the ore is carried. Below this floor are the compartments for water ballast.

During the shipping season of seven or eight months a vessel will make about twenty round trips, or a trip in ten or twelve days. Many

A PANORAMIC VIEW OF THE ASHTABULA, OHIO, ORE DOCKS.

of the newer vessels are designed for towing barges. With this arrangement one of the later style of vessels will tow two large steel barges at a speed of 11 miles per hour, moving an aggregate cargo of 20,000 tons of ore. This constitutes a saving in power, capital invested, and wages paid to seamen.

It is interesting to note * the great reduction in freight rates that the improvement in vessels has made possible—a reduction from $3.00 per ton to 60 cents per ton. These are the transportation charges from upper lake port to lower lake port, and do not include loading or unloading. A reduction of 80 per cent. seems almost phenomenal, and yet it is said that owing to increased draft, larger vessels, more economic engines, prompt loading and discharging, etc., the transportation companies earn as much on the long hauls at this low rate as they formerly earned with the higher rates. Another interesting point is that all this reduction has been made without any reduction in wages; for the fact is that seamen's wages in this class of business have been materially increased in the last twenty or thirty years.

There are a number of very efficient coal-loading docks at the lower lake ports, and a vast number of coal unloading docks at Duluth and elsewhere on Lake Superior, so that many of the vessels which come down the lakes loaded with ore are able to return with a cargo of coal. This is equivalent to another saving in freight on ore. The

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* A table giving these carrying charges for every year from 1854 to 1900 was published in connection with an article by Mr. Hatch in THE ENGINEERING MAGAZINE for August, 1901. Since that time the rates have been almost unchanged.

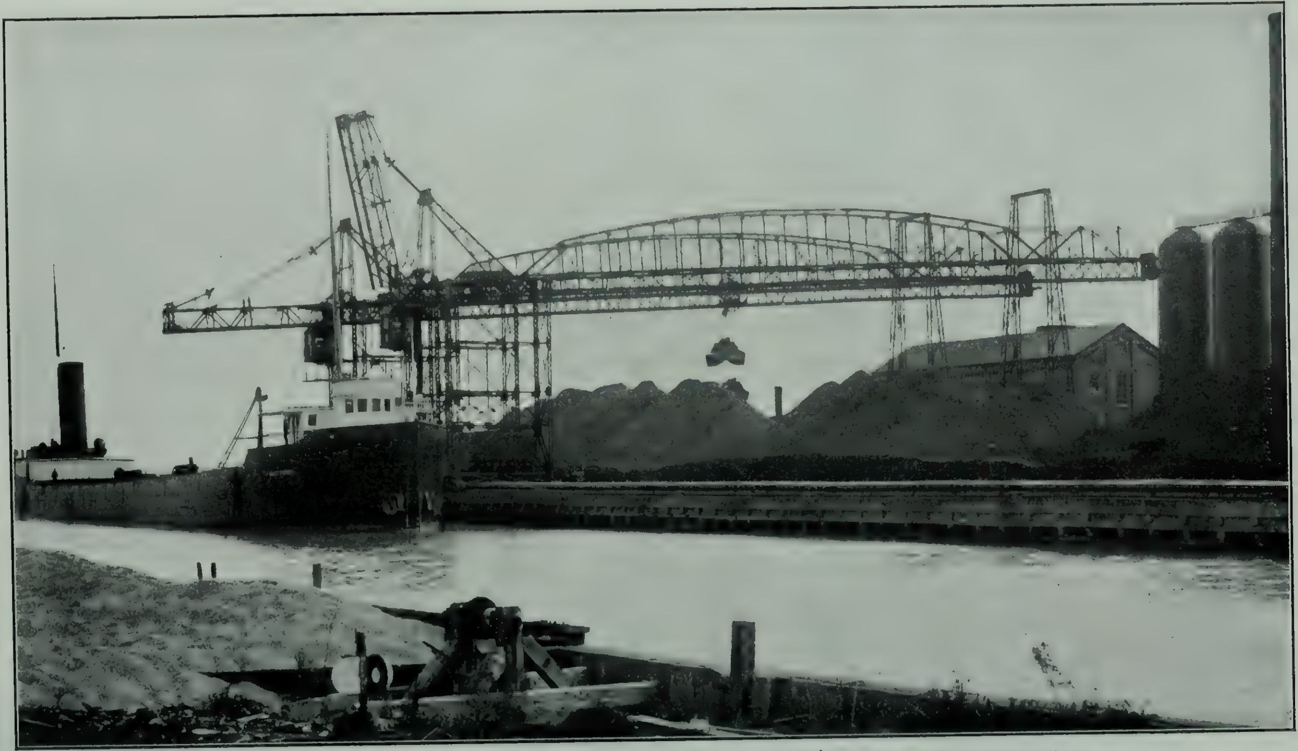
THE ASHTABULA ORE DOCKS. SHOWING BROWN HOISTING MACHINERY.

loading and unloading of coal can be performed fully as rapidly as that of ore.

Among all the docks on the lakes, that of the United States Steel Corporation, at Conneaut, Ohio, is the most interesting. This is one of the newest docks on the Lake Erie shore and is equipped with the most modern and most efficient unloading machinery. It has been gaining more rapidly in receipts than any of the other docks, rising from 1,404,169 tons in 1898 to 3,903,937 tons in 1903, and is destined in a few years to be the greatest of all.

The highly specialized machinery developed for unloading vessels and trains is noteworthy because of the very important part it plays in the production of steel. The problem of unloading the ore from the vessels and of loading into cars for shipment inland was one that could not be solved by a gradual improvement of the older methods, as was the case with mining, loading, and shipping machinery; it required the invention of something entirely new and untried. Very naturally, therefore, unloading machinery was of later introduction, and it may be said even now that this branch of machinery is only in the earlier stages of development. Because it was thus the product of a special invention, to meet a special requirement, these machines exhibit a great variety, representing the many minds of many men.

The first permanent improvement was in the introduction of a cantilever crane, extending from a point upon the wharf out over the

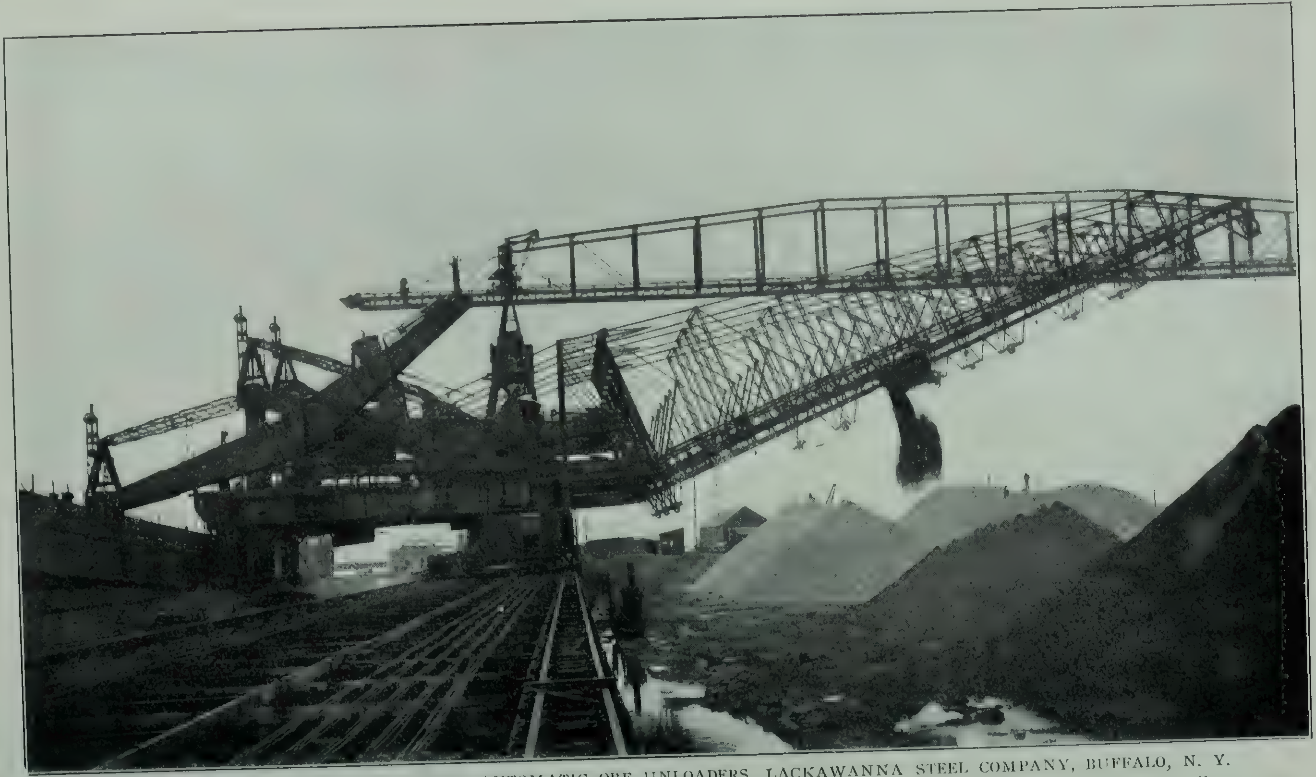


TWO ORE BRIDGES AT THE DETROIT IRON & STEEL COMPANY'S PLANT, DELRAY, MICH.

These are the Hulett patent ore bridges, equipped with Hulett excavating buckets, and are used for unloading ore from vessels to stockpiles, and also for transferring from the stockpiles to bins, over which the cantilevers of the bridges extend. Wellman-Seaver-Morgan Co.

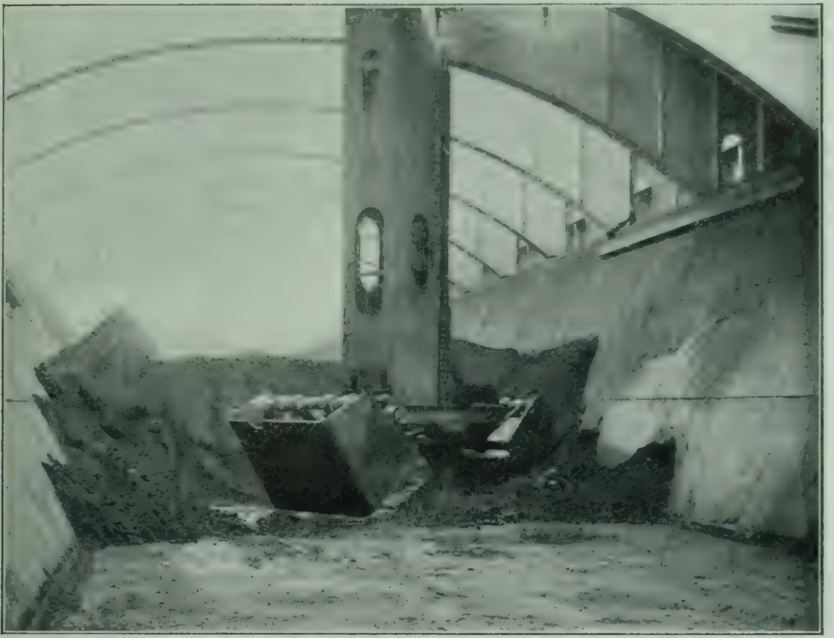
ship. Upon this cantilever a small trolley was drawn back and forth by means of a rope from a hoisting engine. From this trolley a hoist rope raised and lowered the bucket. In this way a bucket carrying a ton or more of ore could be used, instead of a bucket of a few hundred pounds capacity. The buckets, though still filled by hand, could be handled much more rapidly than the smaller ones had been, and the cantilever was long enough and high enough to allow the cars to be so placed beneath it that the buckets could be dumped directly into them. This style of machine was the pioneer mechanical unloader and was a marvel for speed when compared with any previous methods. Unloading that had been accomplished by hand at a cost of 40 or 50 cents per ton could be done with the new machinery at 15 to 18 cents per ton. But the factor that was of prime importance was the possibility, with five or six of these machines, of unloading an ordinary vessel in 10 or 12 hours—an absolute impossibility under the old method.

This class of mechanical unloading machinery was introduced about 1881 and soon proved a tremendous factor in the steel-making industry. Not long after these first machines proved their efficiency, a variety of different appliances were constructed on practically the same lines. In a very few years all the important ore docks were equipped. In fact, it has been only within the last five or six years that anything better than the bridge tramway, about as described above, has been brought out. A number of years ago a bucket had been constructed which would automatically fill itself with coal or gravel or sand. This was tried on ore, as of course it was a source of considerable saving of labor, but was found to be a failure. The ore was so heavy and compact the bucket could not be made to dig into it; and although many attempts were made, by various companies, to construct a bucket that would work on ore, it required several years to accomplish the feat, and the inventors who finally solved the problem were not those who had been pioneers in the field, but men who were comparitively little known in this line of invention. These automatic grabs, of which several types are now manufactured, almost entirely dispense with hand shoveling and have again made a great saving in the cost of unloading, reducing the cost from 15 to 18 cents per ton to 5 or 6 cents per ton, according to some later records. In the Hulett unloader,as shown in an illustration, the bucket picks up 10 tons at a grab and each machine will unload 300 or 400 tons per hour. A record was recently published of a single machine unloading 681 tons in an hour, at the Conneaut docks. The steamship Augustus B. Wolvin (the same ship mentioned in connection with loading), was



THREE OF THE FIVE HULETT PATENT AUTOMATIC ORE UNLOADERS, LACKAWANNA STEEL COMPANY, BUFFALO, N. Y.

The unloader leg of the nearest machine is in the "down" position, at work in the hold of the vessel. In this plant, inclined cantilevers are used to convey the ore to the stockpiles. The unloader bucket dumps into hoppers, which discharge in turn into auxiliary bucket cars; these travel out over the cantilevers and empty their load at any desired point. One is shown just dumping. The bucket cars are automatic in movement, discharging at the desired point and returning, closed, under the hoppers for another load. Wellman-Seaver-Morgan Co.

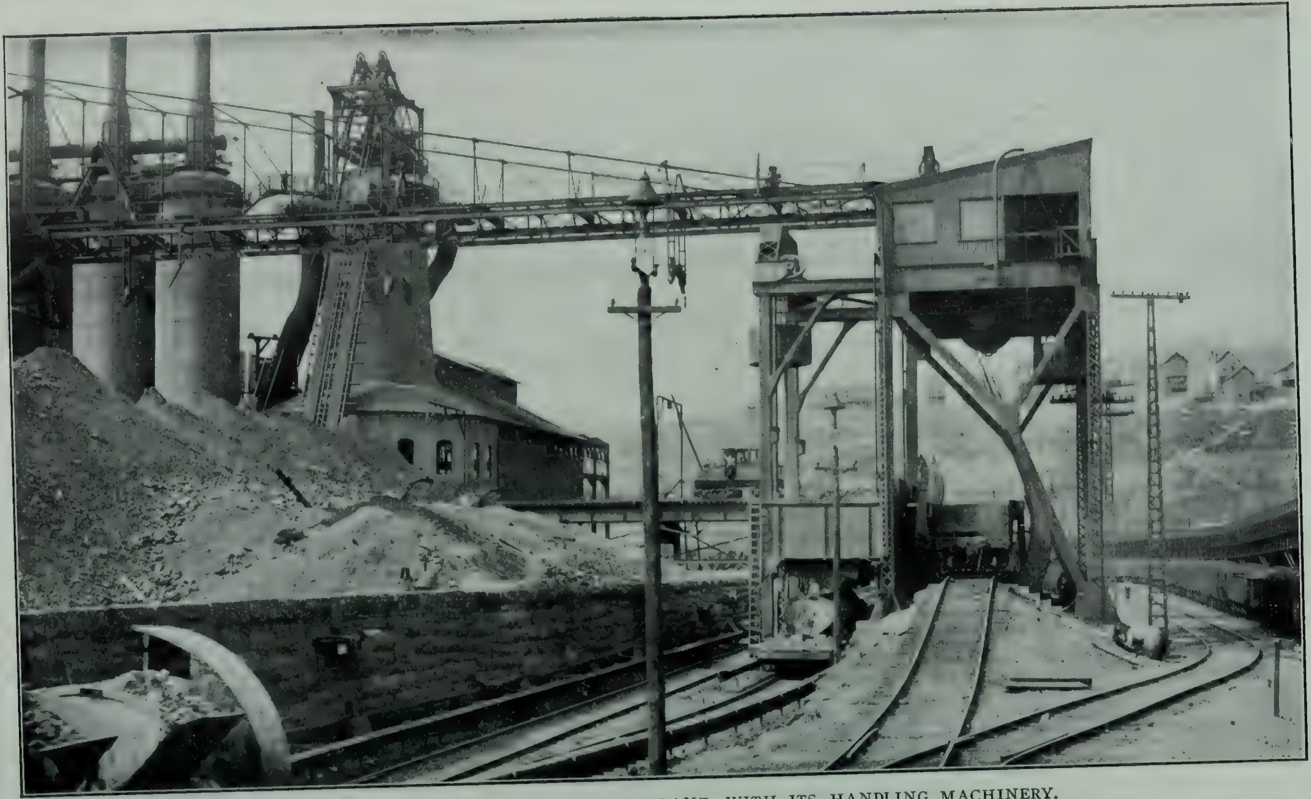


HULETT UNLOADER, WORKING IN THE HOLD OF THE AUGUSTUS B. WOLVIN.

The bucket is of 10-gross-tons capacity, 18-feet total spread of opening; by telescopic extension, it can reach more than halfway from center to center of hatches. The leg travels lengthwise of the hatch, and revolves axially on trunnions in the walking beam. The operator located in the bucket leg, controlling all these motions, can thus reach practically all the cargo. Motion from hatch to hatch and operation of the bucket car are controlled by another operator. Wellman-Seaver-Morgan Co.

unloaded of 11,000 tons of ore at these docks, with the Hulett unloader, in 4½ hours. Half a dozen different kinds of unloading machines, with a total unloading capacity of over 25,000 tons per day, are installed at Conneaut. The docks at Cleveland, Ohio, are supplied with more than one hundred machines, with a total daily unloading capacity of 60,000 to 70,000 tons. With the new methods of unloading there is no necessity of any vessel remaining in harbor more than one day. At the Conneaut docks there is being used a floating fueller which fills the ship's bunker with coal while the ore is being discharged.

With most of these unloading machines the ore may either be dumped direct into cars beneath the machine, or carried back into stock piles for use when lake navigation is closed. As the shipping season is very short every effort is made to get the ore out of the vessel and upon the docks with all possible speed, thus enabling the ships to make the maximum number of voyages during the shipping season. Each day that a large vessel lies idle when navigation is open repre-

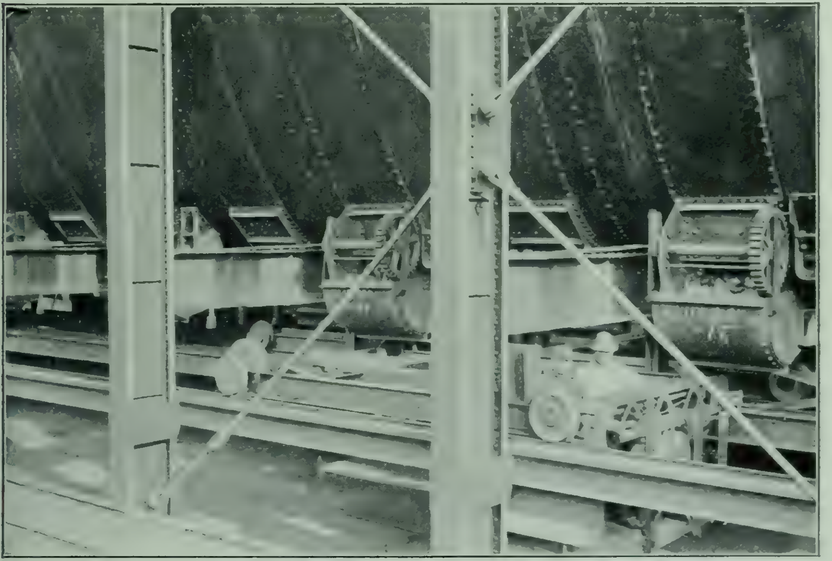


A MODERN AMERICAN BLAST-FURNACE PLANT, WITH ITS HANDLING MACHINERY.

The Carrie Furnaces, Carnegie Steel Co. The car-unloading machine, with an ore car standing on it, is shown on the right. Just to the left of this, between the railroad tracks, is the hopper and beneath it the 24,000-lb. buckets which are hoisted to the ore bridge overhead, carried out on it to the desired point, and dumped onto the stock piles. The furnace hoist and skip are seen in the left background. Brown Hoisting Machinery Co.

sents a loss to the owners of $250 to $300, to say nothing of interest on investment, insurance, etc.

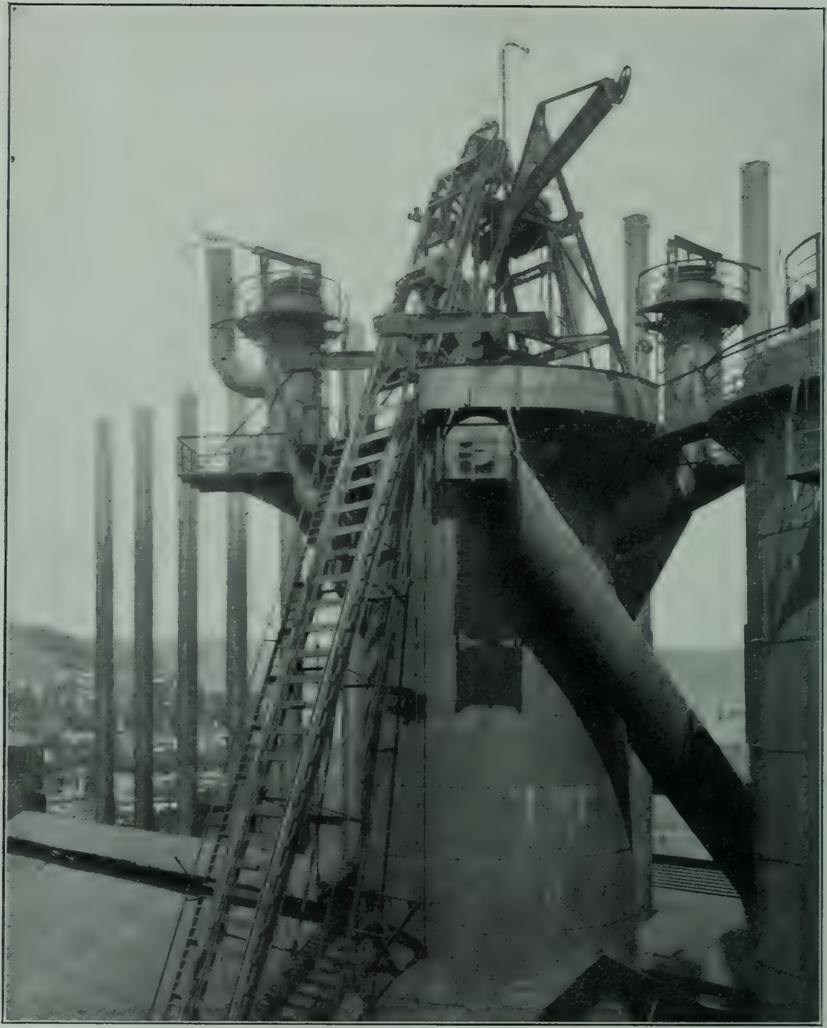
The ore is taken from the unloading docks to the Pittsburg furnaces in long trains of 50-ton steel cars, drawn by some of the largest engines in the world. Upon arriving at the furnaces the question of getting these cars unloaded is the most important one. To accomplish this rapidly and economically, some of the larger furnaces are equipped with a car-unloading and ore-storage plant. With this arrangement the trains are broken up, and new trains are made up with the cars of ore and limestone alternating in the proportion in which those materials will be required at the furnace. A motor, placed behind the string of cars, pushes them one at a time upon the unloading machine. When a car is upon the platform of this machine, clamps are dropped down over the sides, holding it down to the track. The operator, who is located in a house above, then starts in motion the machinery which picks up a section of the track, car, load and all, and turns it through nearly a semi-circle, pouring the ore out of the car into immense hopper bins. The car is then set back upon the tracks and the next loaded car, taking its place on the unloader, pushes the



ORE-BIN GATES AND LARRIES, CLAIRTON STEEL CO., CLAIRTON, PA.

The larry transfers material from the bins to the furnace-hoist skip cars. A small motor on the larry drives a vertical shaft, provided with a universal joint and a male-and-female coupling which is thrown up into mesh by a foot lever. The upper portion of the coupling is fixed to the bin and operates the stationary mechanism operating the bin gates. The larry hopper is of 75-cu. ft. capacity, with bottom dump, operated by the larry man.

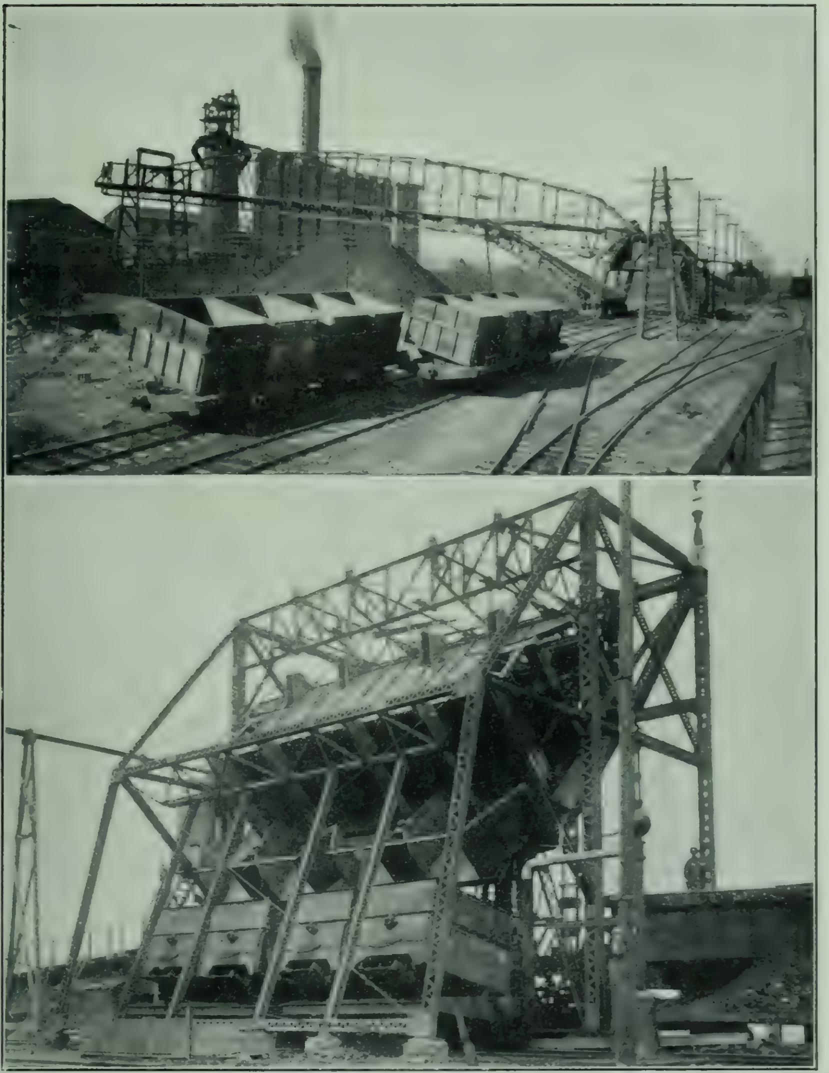
Brown Hoisting Machinery Co.



A MODERN BLAST-FURNACE TOP AND HOIST.
La Belle Iron Works, Steubenville, Ohio; machinery installed by the Brown Hoisting Machinery Co.

empty car off the cradle. The car runs by gravity down from the unloader and into the storage yard for empties. One of these machines, recently installed for the Carnegie Steel Company, is guaranteed to handle three hundred cars per day of 10 hours. The ore after being dumped from the cars is carried back to the furnaces by means of an immense cantilever crane, which handles a bucket conveying 10 long tons, and has a trolley travel of 550 feet.

Estimated simply from an economic standpoint, the larger propor-

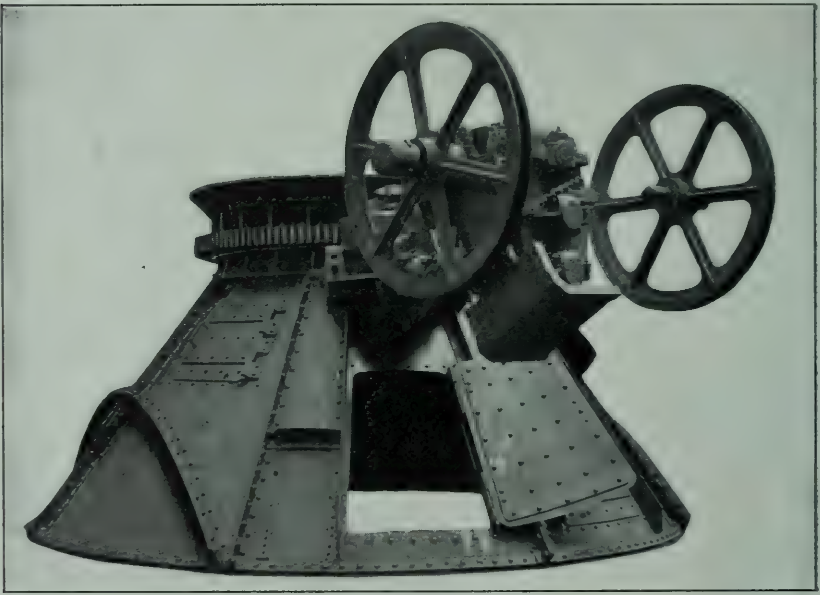


METHODS OF HANDLING ORE. OHIO STEEL COMPANY'S WORKS OF THE U. S. STEEL CORPORATION, YOUNGSTOWN, OHIO.

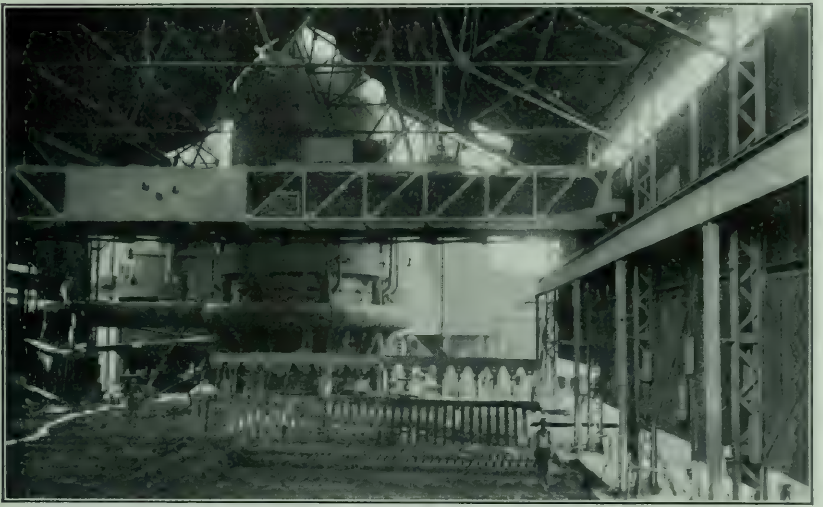
Railroad cars of ore are picked up bodily by the Hulett car dumper, as shown in the lower view, and dumped into "bridge cars," mounted on transfer cars. These latter are pushed by a locomotive into position opposite the bridge incline, shown in the upper view, and the bridge cars are successively pulled up by the haulage rope, run out over the stock pile, and side-dumped at any desired point. The dumping, righting, closing, and latching of the bridge cars is automatic; ore is taken from the stock piles by means of a drag bucket used in connection with the conveyor bridges, the cantilever of which extend over the furnace bins. The machinery is of Wellman-Seaver-Morgan installation.

tion of the actual cheapening of steel is due to the improvement in the methods of handling and shipping the heavy raw material. The actual improvement from a mechanical standpoint, however, is no less marked in the steelworks than elsewhere.

With the old methods, a swarm of men were seen around every open-mouthed furnace, sweating and tugging to move the great masses of hot metal from furnace to ingot molds, or along to the rolls. With the modern methods it is only occasionally a man can be discerned, perched in some out of the way place directing the operations of the ponderous machines. One of the first improvements that may be noted is that at the blast furnaces. Here, the ore, coke and limestone are automatically weighed and mechanically transported to the furnace top; there they are automatically dumped in, landing upon a distributing bell which is kept revolving within the top of the furnace, thus insuring a thorough mixture of the mass. The great furnaces are being continually charged at the top and the molten metal is being continually drawn off at the bottom, without cessation day or night, winter or summer. In the best equipped modern plants the molten metal is taken direct from the blast furnace, in a hot-metal train, to the mixer, and from the mixer to the Bessemer converter or the open-hearth furnace. This saves much time and labor, and permits a considerable economy in retaining the original heat.



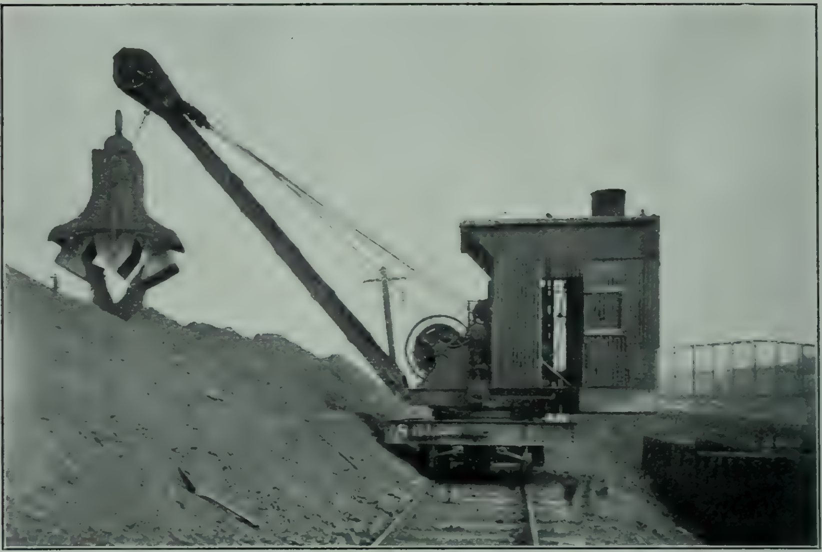
STANDARD MECHANISM FOR DOUBLE-SKIP BLAST-FURNACE HOIST.
Brown Hoisting Machinery Co., Cleveland, Ohio.



CRANE USED IN CONNECTION WITH PIG-IRON BREAKER.
Installed by the Brown Hoisting Machinery Co. for the Salem Iron Co., Leetonia, Ohio.

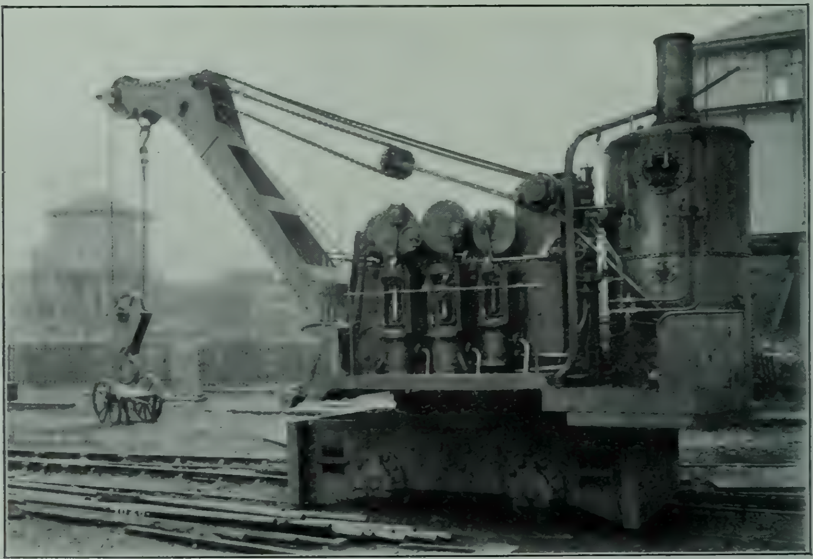
When for any reason it is still necessary to allow the metal to cool into pigs, the Uehling casting machine is used. This moves an endless chain of buckets, each with the capacity of one pig, beneath the ladle of molten metal from the furnace. The metal is then let out in a small stream, and the buckets are moved ahead as fast as filled, the stream running continuously. The chain of buckets then passes on through a tank of water, cooling the iron so that when the chain passes over the sprocket wheel and the buckets are turned up-side-down the pigs

A PIG-IRON BREAKER.
Brown Hoisting Machinery Co.; installed for the Salem Iron Co., Leetonia, Ohio.

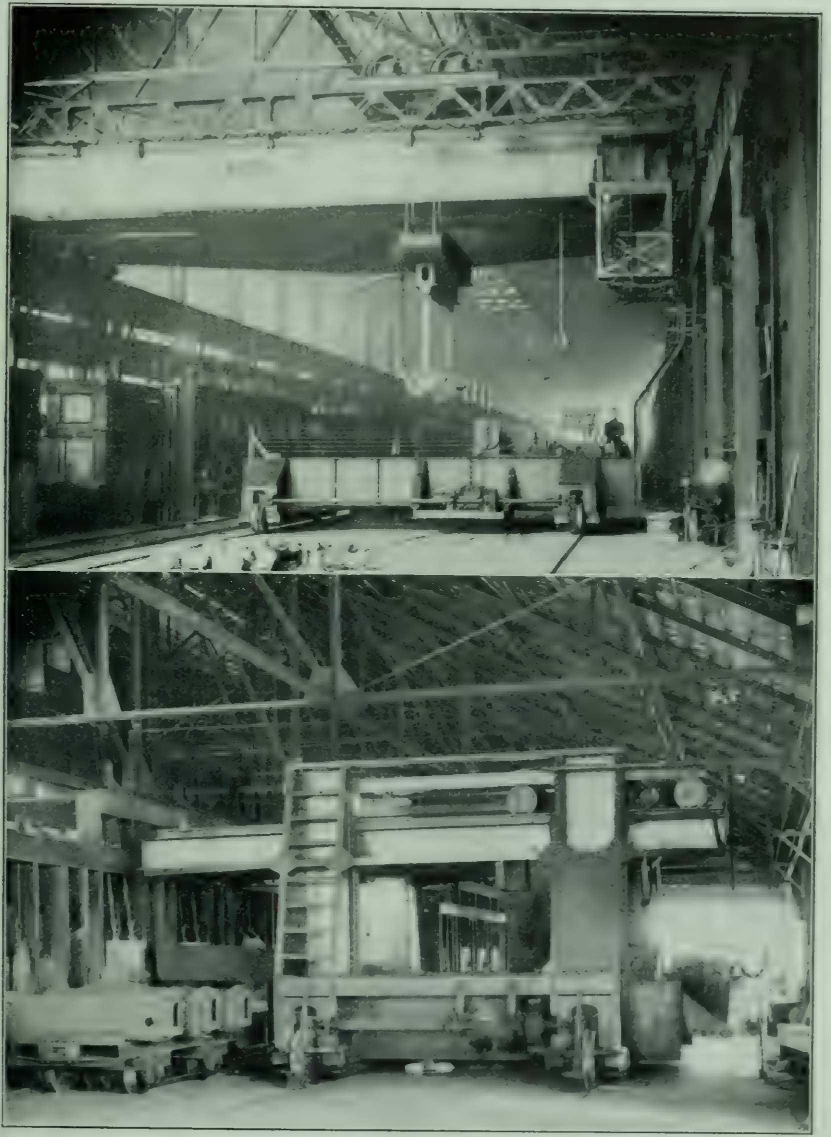


IO-TON LOCOMOTIVE CRANE WITH TWO-ROPE GRAB BUCKET, HANDLING IRON ORE.
Built by Brown Hoisting Machinery Co. for the National Tube Works, McKeesport, Pa.

fall into a car placed to receive them. The pigs thus made are uniform in size and appear much cleaner and more business-like than those made in the old-fashioned way.

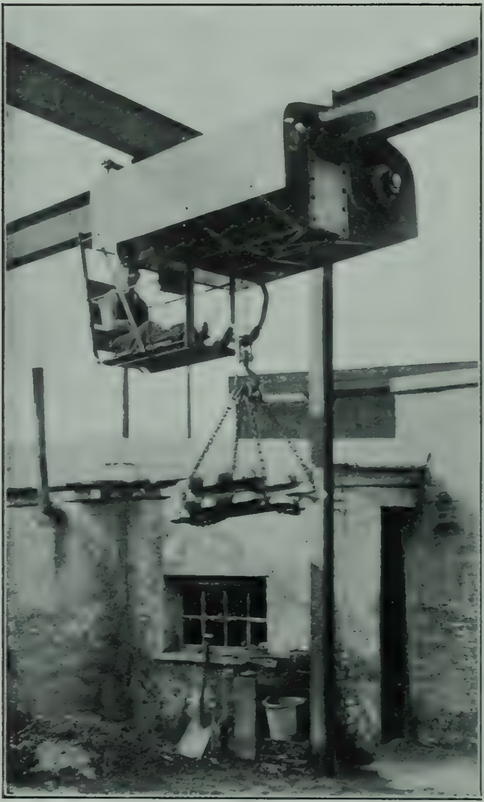


AN ENGLISH LOCOMOTIVE STEAM CRANE FOR USE IN THE STEEL WORKS.
Three pairs of engines. Lifts, slews, and travels with a load of 20 tons at 12-feet radius, 15 tons at 16 feet, and with lighter loads in proportion out to extreme lift of jib.
Marshall, Fleming & Jack, Motherwell.



CHARGING AND HANDLING MACHINERY FOR MODERN STEEL WORKS.
The upper view shows a 40-ton Wellman double-trolley ladle crane (10-ton auxiliary trolley) and Wellman low-type open-hearth charging machine, Sharon, Pa., works of the United States Steel Corporation. The lower picture shows a Wellman high-type open-hearth charging machine and charging boxes, Grand Crossing Tack Co., Hutchinson, Ill. The Wellman-Seaver-Morgan Co.

When the iron is delivered to the converter, either direct from the hot-metal train or after having been remelted in the cupola, it is ready to be converted into steel. The Bessemer converter, a gigantic ma-



ELECTRICAL JENNY, OR TRANSPORTER, FOR CARRYING PIG IRON.

Lifts 25 cwt. at 25 ft. per minute and travels with it at 250 ft. per minute. Jessop & Appleby Bros., Ltd., Leicester.

chine involving and requiring a host of auxiliary machines, did as much as any other one factor in the first development of the steel industry. The open-hearth furnace has since been perfected until it is about as economical, considering the class of ore that may be used.

If the product is a bloom it passes to the mammoth bloom shear, where a knife falls and snips off a solid piece of metal 7-inches square as easily as a butcher would slice off a bologna. These machines have enabled the diversion elsewhere of the labor of scores of men, and each man replaced means a great saving in the cost of steel. There are still, however, many men needed, but it is the brain rather than the muscle now that is required. An expert must watch the converter and judge from the color of the flame when to start and when to stop. Another watches the furnace and decides when the metal is at proper heat for the rolls; but the actual lifting and pushing and turning and drawing of the great masses is done by the pulling of a lever or the changing of a switch from one side of a dial to another.

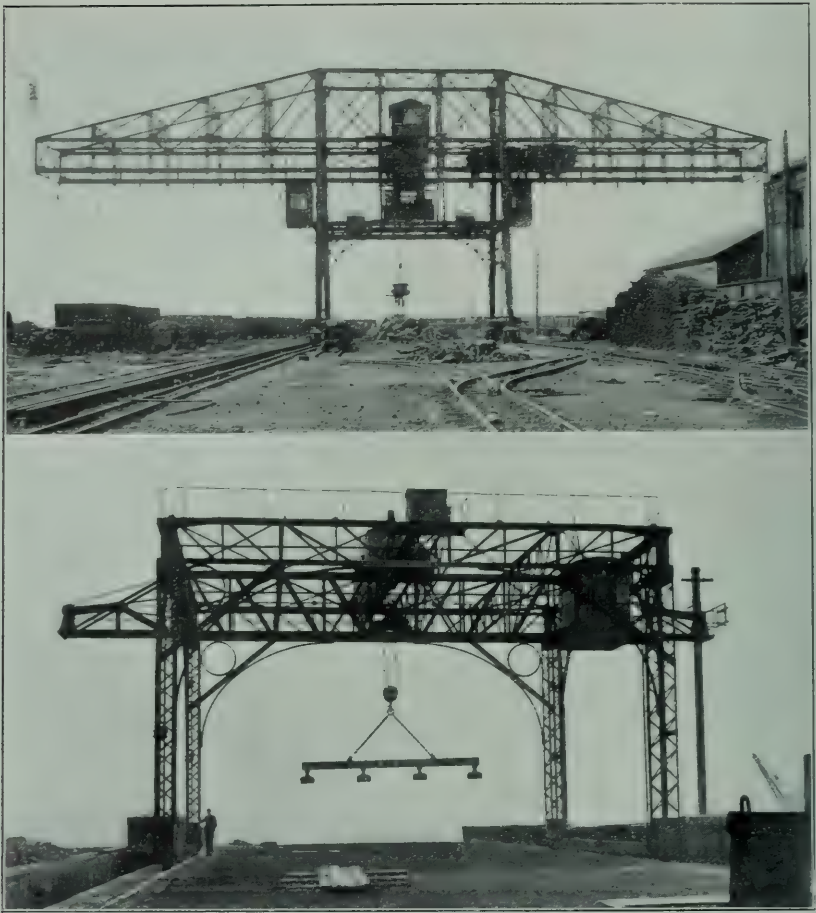
Perhaps no individual mill is more interesting or more complete than that where railroad rails are rolled. As was said, the molten metal is taken from the blast furnace to the converter, where it is a matter of only a few minutes to change it from pig iron to steel. The molten metal is then poured into ingot moulds and allowed to solidify. The moulds are then stripped off by machinery and the ingots taken to the "soaking pit," where they remain a few hours until they are of equal temperature throughout; then they are ready for the blooming mill. In the blooming mill an ingot of steel 18-inches square and 7-feet long, weighing 3 tons, is rolled down to blooms 9-inches square and 15 feet long, by means of nine passes through the blooming rolls, accomplished in 45 seconds. This blooming process also tends to render the mass more constant throughout. The bloom is sheared up into shorter pieces, each of which has sufficient material for a 90-foot rail. These pieces are then taken, while still red hot, to the rail mill. Here each piece is sent back and forth through the rolls, each pass changing the square bloom into something more nearly resembling a rail. Finally the last pass gives the exact shape of the finished rail, and it is carried off to the hot saw. After leaving the rail rolls the rail goes to the hot saw where it is cut to exact length, with allowance for shrinkage. The rail is cambered, and then carried off into the piles ready for straightening, drilling, and inspection.

Beams, angles, z-bars, and all other commercial shapes are turned out in the same way. In material for bridges, buildings, etc., where a great variety of lengths are required, the exact length of each piece or of a number of pieces, is given to the man at the saw and he cuts the material up into the required lengths.

This is something of what is being accomplished in a modern steel plant; but improvements are still being multiplied in every department and no man can contemplate what wonders this will finally lead to. In the

ELECTRIC PORTABLE CRANE, WITH LIFTING MAGNET FOR BILLETS, BARS, ETC.

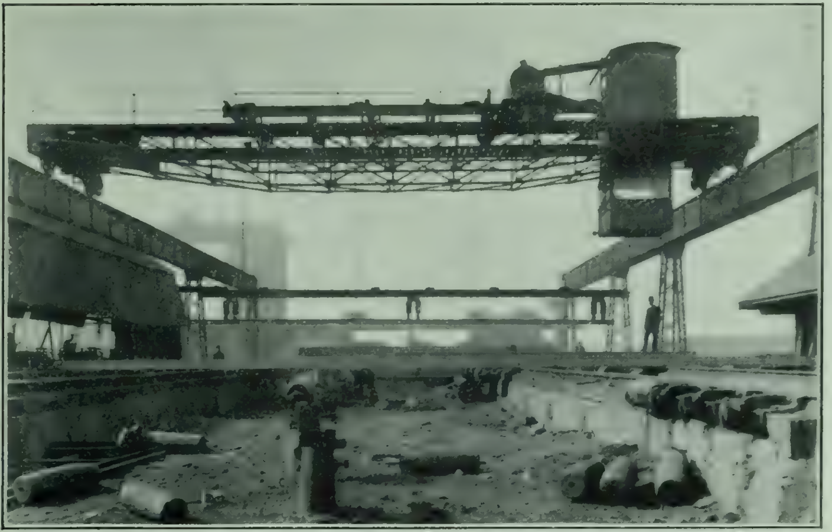
Chambers, Scott & Co., Motherwell.



GANTRY CRANES FOR HANDLING MATERIALS IN THE STEEL WORKS.

The upper view shows a special three-trolley high-speed 10-ton gantry crane installed by the Wellman-Seaver-Morgan Co. for the Lackawanna Steel Co.; it is equipped with magnets for picking up pig and transferring it from large cars to cupola-charging cars, or to the stock pile. The lower figure is a 10-ton electric gantry crane with lifting magnets for the loading bank of D. Colville & Sons' steel and iron works, Motherwell; built by George Russell & Co., Ltd., Motherwell, Scotland.

last forty years the capacity of a blast furnace has been so improved that whereas a furnace of that time which could turn out 200 tons per month was considered a record breaker, now a single furnace will turn out 20,000 tons per month, or 200 tons in three or four hours. A single Bessemer converter can be charged and blown one hundred times in twenty-four hours, turning out 1,500 tons of finished steel; and a single train of three-high rolls will roll into commercial shape 3,000 tons of railroad rails in twenty-four hours, or about 65,000 tons per month.



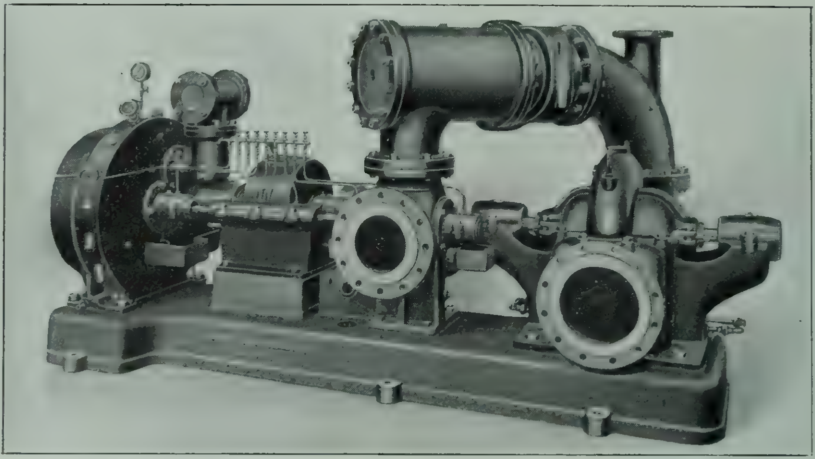
ELECTRICAL TRAVELING CRANE WITH LIFTING MAGNETS FOR HANDLING RAILS, GIRDERS, ETC.

Jessop & Appleby Bros., Ltd., Leicester.

When the steel leaves the rolling mills it has by no means passed out of the sphere of mechanical manipulation—in fact, each individual piece will probably pass through a score of different kinds of machines before it finally comes to rest in the finished structure of which it is destined to form a part. It is loaded into cars by a traveling crane which will pick up 15 or 20 tons at a load. From this crane there is suspended a carrying beam about 20 feet long. At each end of this carrying beam is attached an immense electric magnet. These magnets are lowered upon the flat plate, the current of electricity is turned on, and the magnets with the plate adhering are lifted up and carried to any desired position.

The structural shapes are sent through all kinds of intricate machines, where they are sawed, planed, punched, riveted, bent, and twisted into a thousand different forms. Machinery carries them from the mill to the structural shop, from the structural shop to the building site. With the aid of machinery these finished parts of the final structure are lifted into place and are riveted together.

By machinery, there has been in the last ten years 100,000,000 tons of iron ore taken from the Superior region alone, converted into articles of commercial usefulness, and distributed. By machinery the United States has become foremost in the production of pig iron, turning out 40 per cent. of the world's supply, and exceeding the production of Great Britain and Germany together.



HIGH-PRESSURE CENTRIFUGAL PUMP, DIRECT-DRIVEN BY STEAM TURBINE.
250 gallons per minute, 750-feet head. De Laval Steam Turbine Co., Trenton, N. J.

THE DEVELOPMENT OF POWER PUMPING MACHINERY.

By Wm. M. Barr.

In the following article Mr. Barr touches only upon the most important principles embodied in modern pumping machinery. In a succeeding number he will discuss more fully some of the mechanical applications of water power.—THE EDITORS.

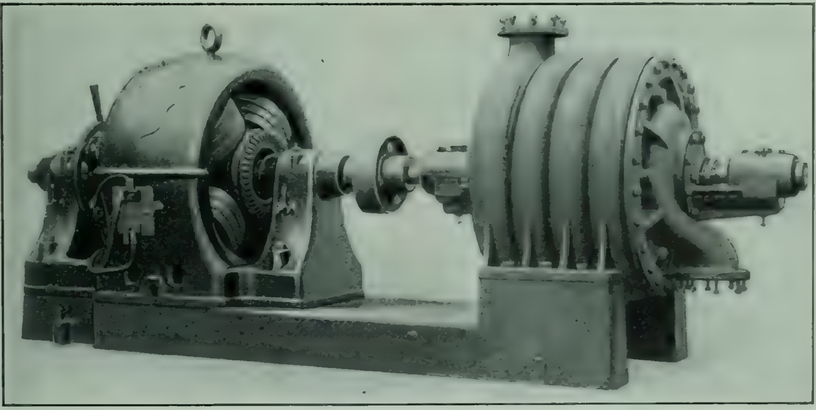
THE earliest labor-saving devices included those for transporting water. The lifting of water to a level sufficient for the purpose of local irrigation was the simple beginning of the modern system of water supply. The work to be done in any hydraulic system is commonly that of lifting water from a lower to a higher level, as in pumping water out of a mine, or in utilizing a head of water to do useful work such as to drive a water wheel, or perform work which may be by pressure or by impulse in a closed hydraulic machine.

Water is valuable as a means of mechanical transport in its negative property of non-resistance to change of shape and its practical non-compressibility. The equivalent head to balance one atmosphere is about thirty-four feet, and, as water obeys the action of gravity with but little loss, pressure systems are easily established and economically maintained. Hydraulic machines are, therefore, extensively used in engineering operations and rarely do they fail in meeting the exacting requirements in labor saving devices.

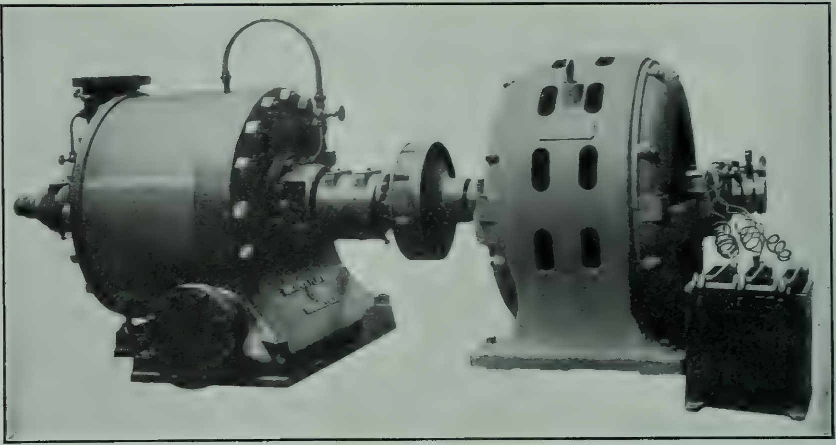
The ordinary lift and force pump enters so largely into present-day economics as to become an indispensable mechanism, whether cperated by hand, by the action of the wind, or in the highly developed triple-expansion high-duty pumping engine.

Utilizing a stream of water so as to make it do useful work in the service of man has always engaged the mind of the thoughtful in all ages, but generation succeeded generation before it occurred to any one to construct the hydraulic ram, the essential principle of which is this:—a mass of water is allowed to flow freely through an inclined tube for a short time and thus acquire a certain velocity, and therefore energy, when its escape through the lower orifice is made suddenly to cease; the momentum of the moving mass then drives up a portion of its own volume to an elevation much higher than that from which it descended, the construction of the machine being such that the acquired energy is expended against the resistance of an air vessel which greatly assists in steadying the flow through the delivery pipe. This principle has advantages over a water wheel or a pump, because it accomplishes the desired object at one operation and in one machine. The efficiency of rams, in practice, varies between 30 and 80 per cent. of the power of the water, depending upon the speed at which it works, size and length of connections, and details cf construction.

The centrifugal pump is commonly employed for raising large volumes of water under low lifts. In principle it is a turbine reversed,



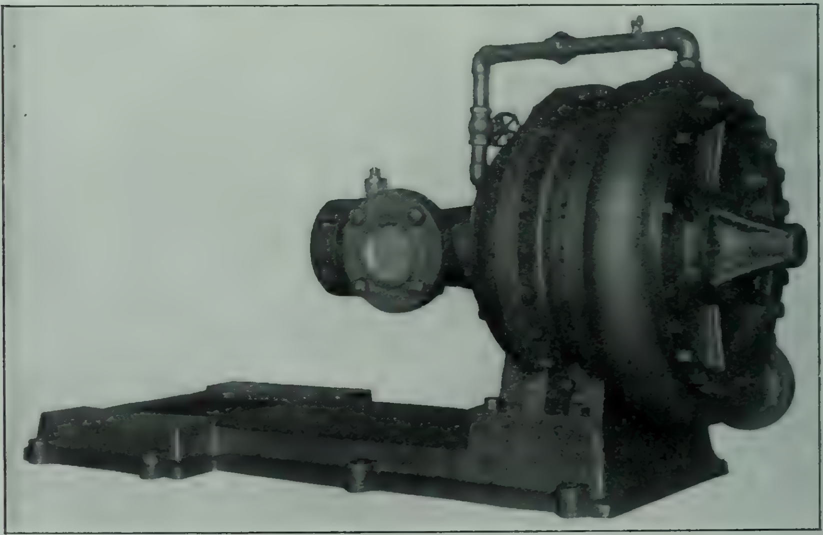
WORTHINGTON FOUR-STAGE TURBINE PUMP.
For a capacity of 700 gallons per minute against a head of 520 ft. Henry R. Worthington, New York.



THREE-STAGE COMPOUND CENTRIFUGAL PUMP FOR DIRECT CONNECTION TO ELECTRIC MOTOR.

To life 1,000 gals. per minute against a total head of 320 ft. Supplied to De Beers Consolidated Mines, Kimberley, by Mather & Platt, Ltd., Manchester.

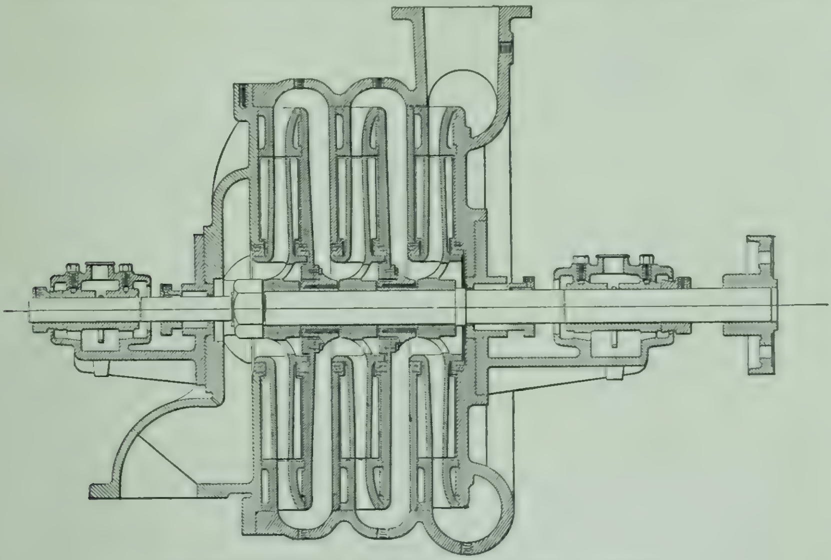
and, therefore, theoretically at least, should have the same efficiency as the turbine. Practically the efficiency is much lower, a good turbine converting about 80 per cent. of the potential energy of the water into useful work, whereas the effective work in lifting water by ordinary centrifugal pumps rarely exceeds 55 per cent. of the work applied. In the newer designs, the suggestion of Professor Thomson



FOUR-CHAMBER HIGH-LIFT CENTRIFUGAL PUMP, DIRECT-COUPLED TO POLYPHASE MOTOR.

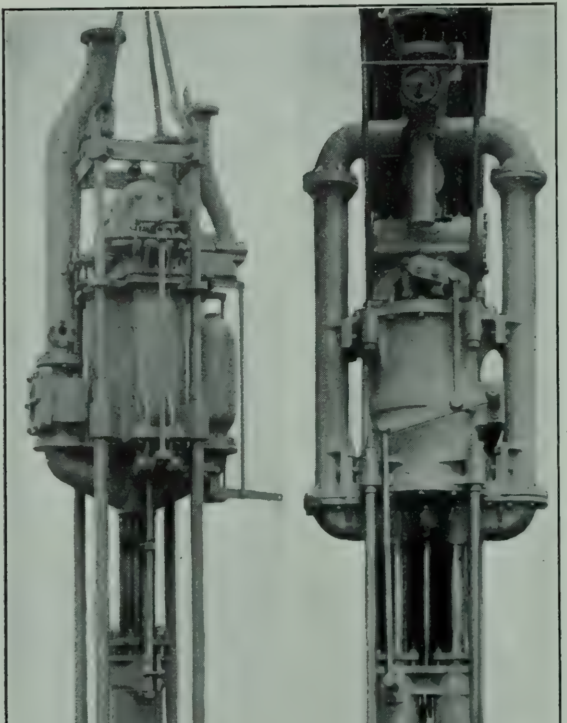
Morris Machine Works, Baldwinsville, N. Y.

that the water leaving the wheel should be discharged into a chamber in which a free spiral vortex could be set up, thereby partly converting the kinetic energy of the water leaving the wheel into pressure head, has been generally adopted. In a pump in which four guide passages were used, the efficiency was found to be much greater than in the case of a free vortex delivery, converting from 70 to 75 per cent of the kinetic energy of the water leaving the wheel into pressure head at the discharge. The number of guide passages should not be less than four, and the areas at inlet should be such that the velocity of flow into the passages should be equal to the velocity of discharge from the wheel, to avoid losses from sudden changes of velocity. Centrifugal pumps in multiple-stage construction can be adapted to any capacity and are now being built for heads up to 1,000 feet head or higher.



SECTION OF WORTHINGTON MULTI-STAGE TURBINE.

Vacuum pumps have long been used. In fact, they are among the earliest forms of steam pumping engines. The pulsometer is exceedingly simple, consisting of two bottle-shaped chambers joined together side by side, with tapering necks bent toward each other, and uniting in a common upright passage to which the steam pipe is attached. A valve is located at the bottom of each chamber; a small rolling valve is fitted at the top of the two chambers, closing one or the other, depending upon the outward flow of water from one chamber, or a vacuum in the other. Pulsometers will readily handle large



EXAMPLES OF SINKING PUMPS.

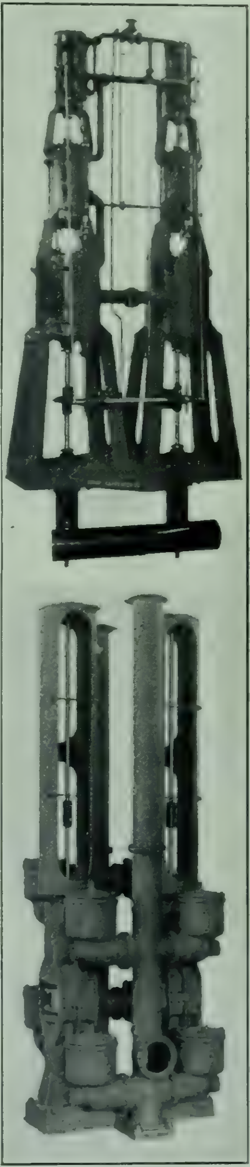
On the left, a double-plunger sinking pump by the Pulsometor Engineering Co., Ltd., Reading. On the right, a Denaby sinking pump by W. H. Bayley & Co., Ltd., Manchester.

volumes of water, whether clear or muddy, but the duty is low, averaging about 7,500,000 foot pounds of work done per 1,000 pounds of steam used.

Raising water by compressed air has, under favorable conditions, certain advantages such as the absence of all moving parts common to ordinary pumps, but there must be an air compressor and an air receiver. The well having been piped for the delivery of water, a small pipe attached to the air-receiving tank is led to the well and thence downward to near the bottom, where it enters the water discharge pipe. The proportion of these two pipe diameters is commonly 1 to 4. For each 100 feet of total lift, the submergence should be from 50 to 60 per cent. to get the best results.

Reciprocating pumping engines are the ones in general use, the plungers being either horizontal or vertical as will best suit the local conditions. Nearly all pumps are double-acting, that is, consist of two sets of inlet and delivery valves with a reciprocating plunger or piston working in a barrel communicating with the two valve chambers. Such pumps are, therefore, both suction and delivery pumps. The flow of water through such a pump is intermittent, and to relieve the pipes and the pump itself from violent shocks an air chamber is provided. The largest air chambers are required for single pumps; much smaller ones will suffice for duplex pumps, and, in some cases, they are omitted altogether.

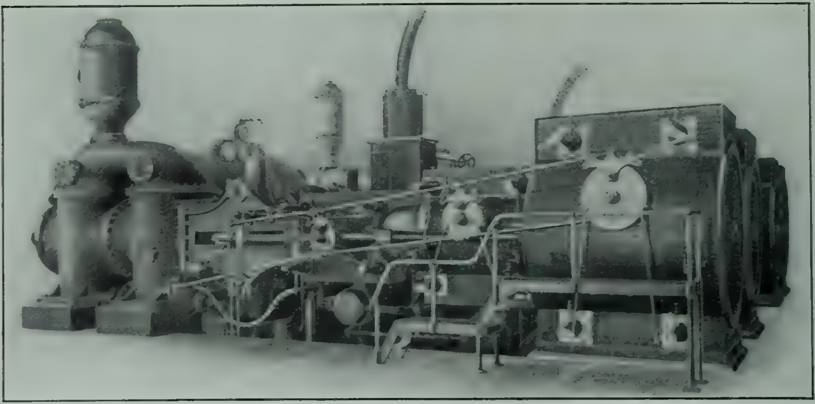
Ordinary direct-acting steam pumps are very wasteful of steam, more so perhaps than any other type of steam-driven machinery. Tests made to determine the efficiency of the auxiliary machinery on board the United States warships showed that as much as 200 pounds of steam were used per indicated horse power per hour. For small water-works plants and other service where a constant supply of water is required, an economy is had by compounding the steam cylinders, though in most cases even this does not give the economy supposed. Large compound condensing pumping engines of the duplex type yield a duty of from 50,000,000 to 70,000,000 foot pounds per 100 pounds of coal burnt. This is the best average duty which can be expected of similar pumping engines in mines, acting under the best conditions.



STEAM AND WATER ENDS, 5,000,000 GALLON PUMPING ENGINES.

Cylinders 13, 19, and 30 in., water plungers 20, stroke 36. Epping-Carpenter Co., Pittsburg.

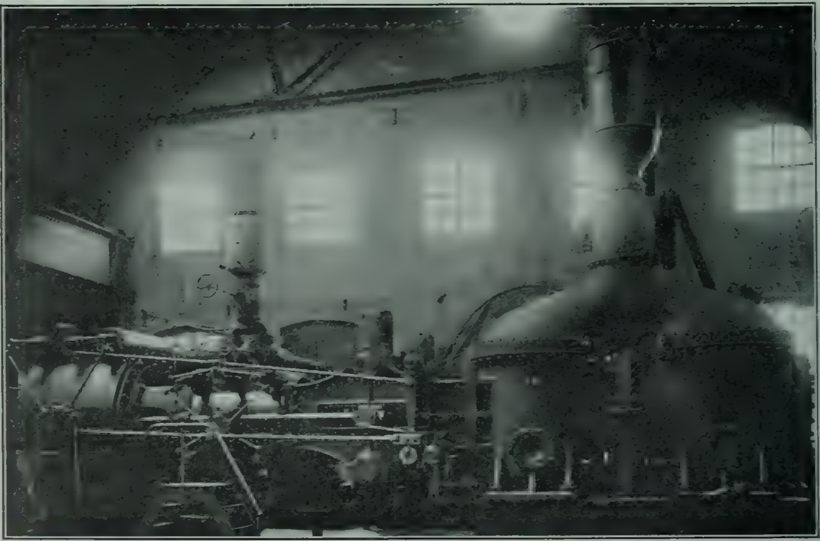
A compensating device applied to the water end of a direct-acting pumping engine by which a degree of steam expansion similar to that of rotative steam engines becomes prac-



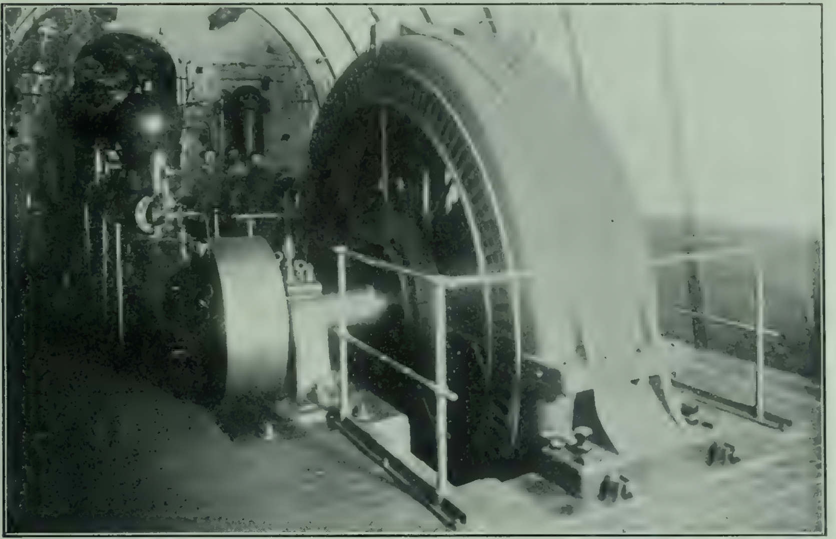
HIGH-DUTY TRIPLE-EXPANSION PUMPING ENGINES, MOUNT ROYAL STATION, BALTIMORE.
Daily capacity 17,500,000 gals. each; duty on official trial, 142,334,000 foot pounds per 1,000 pounds dry steam. Henry R. Worthington, N. Y.

ticable, will yield a correspondingly high duty. More than 100,000,000 gallons can be secured under good average conditions, using steam of 160 pounds per square inch.

Crank and fly-wheel pumping engines have yielded the best average high-duty performance. The pumping engine at the Chestnut Hill Low Service Station, Boston, Mass., has steam cylinders of 17, 31¼, and 48 inches diameter by 60 inches stroke; the water end con-



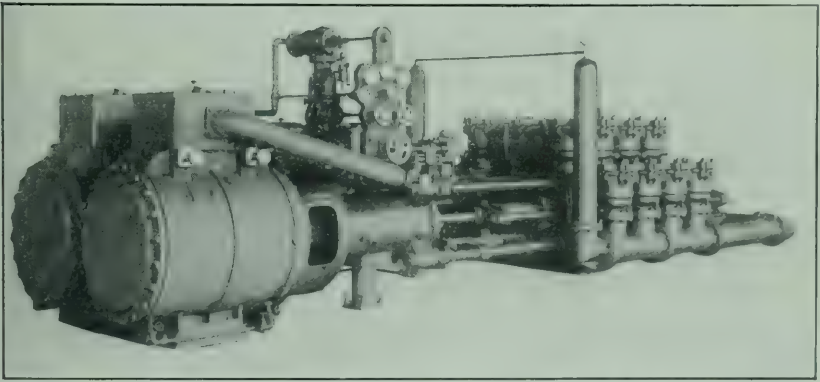
"WORTHINGTON" HIGH-DUTY DIRECT-ACTING PUMPING ENGINE, LANCASTER, PA.
One of the latest large installations built. R. D. Wood & Co., Phila.



UNDERGROUND ELECTRICALLY DRIVEN PUMP, SOCIÉTÉ ANONYME DES HOUILLÈRES UNIES DU BASSIN DE CHARLEROI.

Schleifmühle express pump, by Ehrhardt & Sehmer, driven by International Electric Company's three-phase motor.

sists of three single-acting plungers 37 inches in diameter. The valve area is 200 per cent. larger than the plunger area. At 30 revolutions per minute the plunger speed was 300 feet per minute. The average net head pumped against was 45 feet. The efficiency of the mechanism was 88.84 per cent., with thermal efficiency of the engine of 20.50 per cent. With steam pressure at 150 pounds per square inch, the duty of the engine, based upon plunger displacement, was 158,574,000 foot pounds. As this represents an indicated horse



WOOD LINED PUMP FOR 800-FT. LIFT, P. & R. COAL & IRON CO.

Jeanesville Pump Co., Hazleton, Pa.

power for each 11.08 pounds of dry steam, but little is to be expected in the matter of greater efficiency.

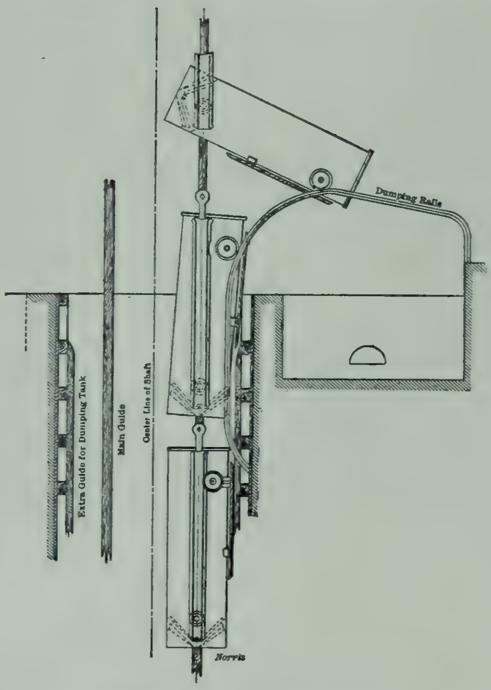
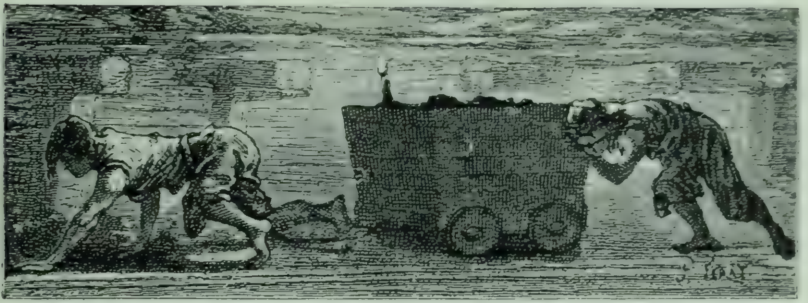


DIAGRAM SHOWING GUIDES AND METHOD OF DUMPING, WATER HOISTING BY MEANS OF DUMPING TANKS.

R. V. Norris, T.A.I.M.E., Feb., 1903.

Water hoisting from deep mines, by means of tanks instead of by pumping, is now coming into favor in the anthracite region of Pennsylvania. Many of the large collieries are now hoisting water in this manner, and others are thus equipping their mines in lieu of pumps. At the William Penn Colliery of the Susquehanna Coal Company, the tanks are about four feet in diameter by some sixteen feet in height, the estimated capacity being 193 cubic feet with a rated capacity of 281,400 cubic feet in 24 hours, the mine being 953 feet deep; this is equivalent to more than 2,000,000 gallons per day. These tanks are constructed with two butterfly valves at the bottom, set at an angle of 45 degrees. A sump is provided in the mine into which the tank descends; after filling it is hoisted to the top of the mine where it pours its contents into a discharge basin, from whence it can be led to any convenient waste. The duty of such a water hoist varies between 30,000,000 and 40,000,000 foot pounds per 1,000 pounds of dry steam. In this case a pair of engines 32 by 48 inches with drum 12 feet in diameter handled water at a cost of $0.0234 per 1,000 gallons, or $0.1755 per 1,000 cubic feet.



"PUTTERS" OR TROLLEY BOYS IN AN ENGLISH COAL MINE, EARLY NINETEENTH CENTURY.

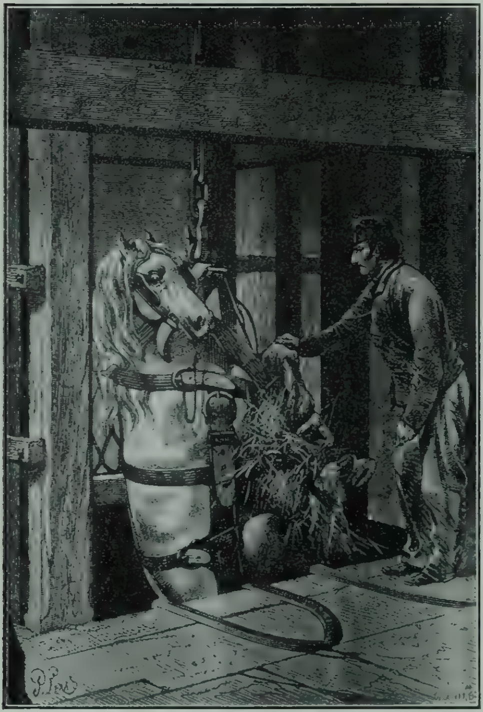
Women and girls were employed at the same work up to 1843.

A DISCUSSION OF METHODS OF UNDERGROUND TRANSPORTATION.

By John Bonsall Porter.

Mine transportation, to be properly discussed, must be considered under two heads—haulage and hoisting. It is unfortunate that time and space permit the treatment of one only in a single article, for the two are so inter-connected that neither can be shown alone in its true perspective. In many mines haulage and hoisting are one—the haulage road reaching from the surface to the extreme bottom, but being so steep that its function is really closest to that of hoisting. In others, the haulage roads are graded to the shaft to lighten the work of horse or hand tramming, the saving thus effected more than off-setting the added hoist. In still others, including many collieries, the shaft cuts the bed at an intermediate depth and the haulage system is required to raise the material from the deeper workings to the shaft level. Only in the comparatively few mines in which the workings are reached by tunnels to the rise in hillsides are haulage and hoisting separated (by the elimination of the latter). In all other cases they are so closely related that each is dependent upon the other for its success. Dr. Porter's paper is therefore but initiatory to the complete discussion, and is to receive its complement in a review of hoisting to be presented later.—The Editors.

THE statistical sheets recently published by the United States Geological Survey show that in 1903 the mines of the United States produced about 350,000,000 tons of coal and 70,000,000 tons of ore and other mined minerals. American statisticians do not distinguish between mining proper and quarrying or open-cut mining, but it is safe to assume that 325,000,000 tons of coal were produced in underground workings at an average distance of at least 3,000 feet from the pit's mouth. A larger proportion of the ore was produced by open workings, but underground mining probably yielded 45,000,000 tons for which an average haul of 300 feet may be assumed. We thus have an aggregate haulage underground of about 180,000,000 ton miles in the United States alone.

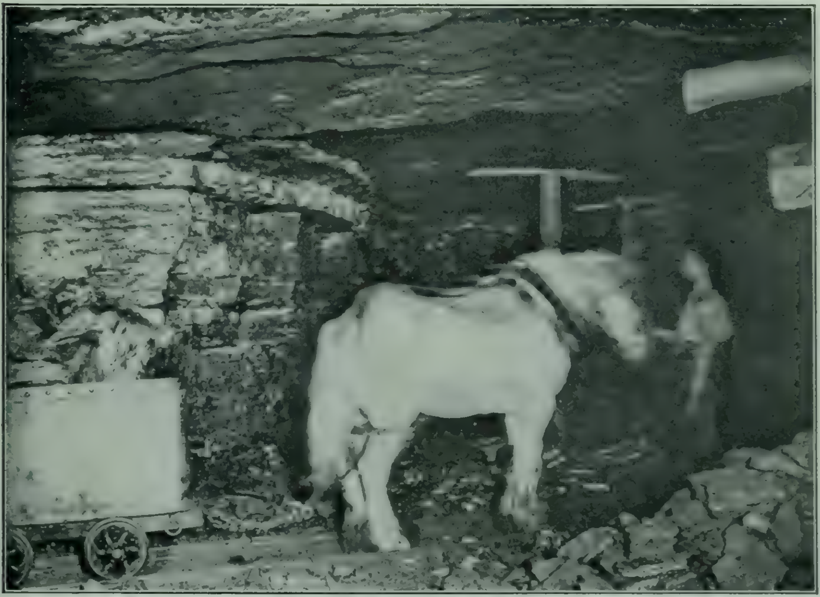


LOWERING A HORSE INTO A MINE.

If we extend our enquiry and include the mineral production of the whole world, we find that underground mining produced last year not less than 1,000,000,000 tons of mineral, of which over 80 per cent. was coal; and the transportation of this material involved nearly 500,000,000 ton miles of haulage, and probably 70,000,000 ton miles of hoisting. These figures are rough approximations only, but they suffice for our purpose, and show that underground transportation is a subject worthy of the most careful attention of engineers and managers. A not inconsiderable part of the mineral above referred to was produced by a great number of small mines in which simple—and in some cases almost primitive—methods are of necessity employed, but by far the greater part came from comparatively large plants, in which economies of transportation are or should be considered as carefully as if on the surface. It will therefore be interesting to see how far the mineral industry of the present day has benefited by the devices and methods of modern engineering.

With a few notable exceptions, the mines of a century ago were small. Shafts were occasionally quite deep, but, owing to the great first cost and limited capacity of the pumping and hoisting apparatus then available, only a small territory could ordinarily be worked from each shaft. The material mined was usually hauled in sleds or little waggons, or even carried on the backs and heads of the work people from the face to the hoisting apparatus. In some places horses were in use and rough tramways were laid with planks or even with cast-iron plates, but in general the workings were too small and tortuous for anything but human transportation, or perhaps we might now call it *inhuman*, as women and boys did most of the work.

The first half of the nineteenth century brought many improvements. Hoisting and pumping machinery were greatly simplified and cheapened, thus making it economical to work much larger areas from each shaft. The labour of women underground was prohibited, and motives of economy as well as humanity caused a general introduction of horse haulage in collieries, although the wheelbarrow and even cruder devices remained in almost universal use in ore mines as in fact they remain in many places even to the present day. Until about 1840 such mine cars as were in use were really buckets or corves, provided often with small wheels to facilitate their handling, but moved from loading place to shaft bottom on wheeled platforms or rolleys, thence hoisted to the surface, emptied, and returned to the pit. About the year mentioned corves and rolleys began to give way to cars very similar to those now almost universally used, the roadways being at the same time improved and laid with better rails. Slopes operated by ropes were already in use, and within the next twenty years these became comparatively common and were developed into more or less elaborate systems of main, tail, and slope-rope haulage. The condition of affairs in the best mines of the day is clearly set forth in a report by a committee appointed by the North of England Institute of Mining Engineers in 1867 in which the several systems of rope and endless-chain haulage then in use are described and discussed. Tail ropes and endless chains are recommended for

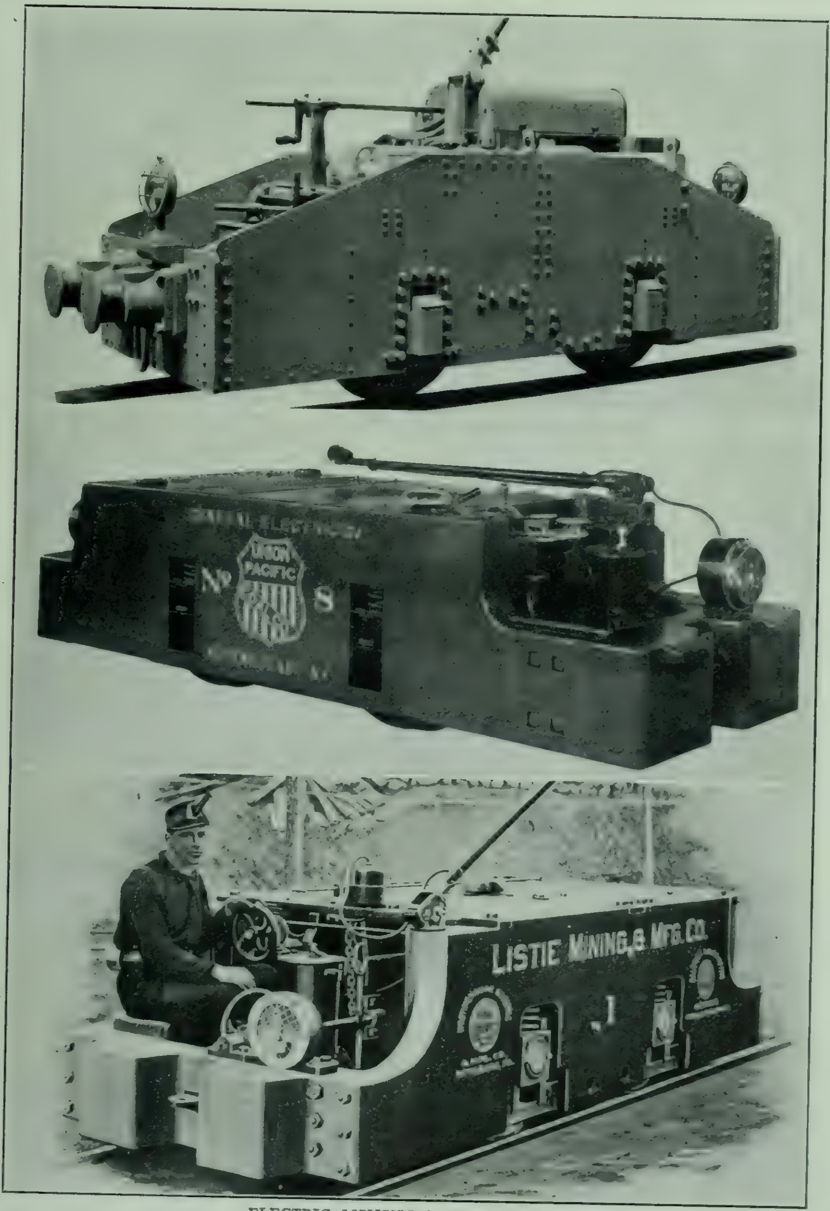


HORSE HAULAGE IN A COAL MINE, SOUTH STAFFORDSHIRE, ENGLAND.

ordinary use, while endless rope is recommended only for certain special cases. Of the eleven selected English plants discussed by the committee three were slope and tail-rope systems with an average working tonnage of 503 per shaft. Five, with an average tonnage of 342, were endless chains, and three, with an average tonnage of 350, were endless rope. Horse haulage was of course used in all of these mines to bring the cars to the main tramway, and boys were employed to carry the coal from the working places to the cars, in many instances, and to actually haul the cars in some cases. The success of these mechanical-haulage devices and of important improvements in ventilation, which were introduced at about the same time, greatly increased the territory accessible from a single opening, and coal mines in all civilized countries were soon equipped with mechanical devices more or less equivalent to the street-railway cables so commonly used in our cities a few years ago.

In 1870, a steam locomotive was used underground in one of the collieries in the United States. In 1882, an electric-haulage plant was installed in the Zaukeroda colliery, in Saxony, compressed-air locomotives having been employed in England and elsewhere shortly before. The first electric locomotive used in the United States was at Lykens Valley, in 1887. As might have been expected, the steam locomotive has not proved very successful underground; but pneumatic and electric machines have become increasingly common, and while it is impossible to state their present number or their proportion of the world's tonnage, it is safe to say that there are in the United States alone not less than 2,000 electric and probably about 150 pneumatic locomotives in underground service.

In surface transportation, when a system is improved upon, its older forms rapidly become obsolete and are abandoned. Horse cars and cable cars are no longer seen in any important service, although an enormous number of them were in use only a few years ago, and even the peumatic and the earlier electric cars have almost disappeared. In mining, the conditions are very different. When a plant is once installed, it is usually left in service until it is worn out, or until there is some very pressing reason for changing it. It is out of sight of the public and is rarely subject to competition, much less to comparison with other and more modern installations. While this condition often retards development, it is not an unmixed evil, as a mine usually has but a limited period of profitable operation, at the end of which it is abandoned. It cannot therefore bear excessive expenditures on capital account, even when they cheapen operating costs. The result is that we have in the mines of the present day,



ELECTRIC MINING LOCOMOTIVES.

The topmost is by Mather & Platt, Manchester, 2 ft. 5½ in. track gauge, 5 ft. 6 in. by 5 ft. 3 in. load gauge, weighing about 4 tons; tractive power 1,100 lb.; speed 10 miles; 500-volt current. It was supplied to a mine in Spain. The middle one is by the General Electric Co., Schenectady, N. Y. The lowest is by the Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

and often in plants working under almost identical conditions and in close proximity to one another, examples of almost every type of mine haulage that has been developed during the last century, and it is therefore possible to compare these different methods on a fairly even basis, and to discuss the conditions under which the use of each is justifiable. Taking the systems then in historical order, let us first describe and then briefly comment upon them:

TRAMMING IN THE TAMARACK MINE, MICHIGAN.

Human haulage with sleds and baskets holding about 100 pounds is said to exist even at this late date in some of the very thin ironstone and coal mines of Great Britain, and it is, of course, common in out of the way countries, where labour is very cheap. Tramming under somewhat better conditions is still very largely employed in all countries. Even in collieries where the seams are thick, cars are moved at the face and trammed short distances. In thin seams, especially where the long-wall system is used, this hand tramming is carried on to a much greater extent, as roads high enough for horse or power haulage have to be cut partly in rock, and are therefore too costly to be very close together. In metal mines, which usually have several levels working at once, each with comparatively short hauls, human labour is still more commonly used, and probably 90 per cent., if not 95 per cent., of all ore both in America and elsewhere, is still hand trammed from the working places clear to the shaft.

The use of horses and mules is still increasing in spite of the fact that power haulage is far more economical. This is chiefly due to the fact that until very recently power haulage has been confined to the main roadways; and although animals have ceased to give economical service there, it has been found necessary to employ increasing numbers of them for secondary service, and the great extension of the mineral industry has caused this secondary work to grow to greater proportions than that of the total haulage of a few years ago. It is almost impossible to get any accurate figures as to the actual number of animals employed at present, but in the State of Pennsylvania alone 29,771 horses and mules were employed underground in 1903. A large number of these animals are stabled in the mines, and, after once going below never again see daylight, although their average life in mining service is probably not less than seven years.

Rope haulage as now employed in mining is of two different types. First, that employing gravity for taking the cars one way, and therefore akin to slope hoisting. Second, endless-rope haulage, which has much in common with the cable transportation recently used for street-railway service. The first system, as employed in long and steep slopes reaching to the surface, can properly be referred to hoisting, and need not be further discussed; but in all collieries where the seams are at all steep, there are places where underground slopes can be used to advantage, and the cars in this way lowered from the rise workings to the main road, or raised from the deeps to the shaft, or to some line leading to it. The simplest form of this arrangement is seen in the jig or balance employed when working to the rise in moderately steep seams. The main roads are

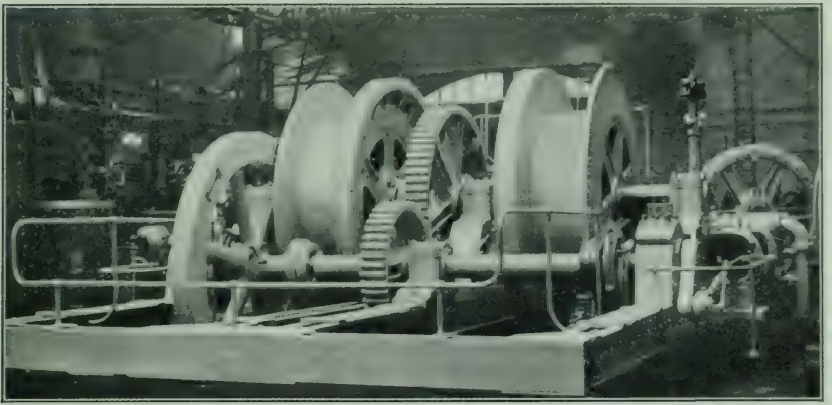
DUMPING A CAR INTO AN ORE BIN IN A MINNESOTA IRON MINE.

driven almost level, and from these, rooms are broken off and cut into the coal either directly up the pitch, or, if that is too steep, at an inclination to it. Temporary tracks are laid up these rooms as the work progresses, and at the top of each a small sheave is attached to a stout post and around this a rope is passed and connected with two cars, one at the top of the track and as close to the work as possible, the other at the bottom, and empty. As soon as the upper car is loaded it is started down the track, which is arranged with a double line at the passing point, and the empty car is thus automatically raised to the working place, the load being taken off to the main line by the secondary haulage and replaced by another empty, while the new car is being filled. Similar devices, but of more substantial construction, are used to connect any groups of rooms, which happen to be at a high level, with main lines below them, and the tonnage thus handled by gravity is very large in the aggregate. In the case of workings on the dip side of the haulage lines, these inclines have to be run by power, but when served by small electric or pneumatic motors, they are very economical and satisfactory.

The slope-rope system is a modification or development of this system of power-rope haulage. An engine provided with a winding drum of the necessary capacity is placed at the head of an inclined

SELF-ACTING INCLINE HAULAGE OR JIG.

The gear is placed at the top of a room when working to the rise, and when a car has been loaded it is lowered. Its weight draws up an empty car to take its place.



A HAULAGE ENGINE FOR HEAVY WORK.
Hauls 50 tubs, each weighing 13¼ cwt., up an incline 1,800 yds. long; 500 yds. is on a grade of 1 in 6, the rest 1 in 20; maximum speed 1,300 ft. a minute. Twin cylinders 17½ by 36, drums 6 ft. diam.; 370 indicated horse power.
Fraser & Chalmers, Ltd.

road leading to the deeper workings, and trips of cars, often aggregating a considerable train, are lowered by gravity to any point where they are needed. The rope is then attached to trains of loaded cars which have been made up, and these are hauled out and delivered either to the hoist direct, or to some other system of transportation connecting with it or the surface. This system requires single track only, and a single plant can be used to work a number of slopes if they can all be reached by gravity from the same starting point. Its disadvantage is that the service is of necessity intermittent, and that the hoisting suffers from successive periods of congestion and a dearth of cars; furthermore, its capacity is very limited unless high speeds are employed, and haulage at high speed necessitates costly track, and often involves derailment and serious loss of time and money. The system is admirably suitable for comparatively small mines on inclined seams, and for isolated portions of larger establishments; and by a modification technically known as the "main and tail-rope" system, wherein a light rope from a second drum is carried to the end of the road and brought back to connect with the lower end of the trip, it can be applied to roadways in which the grade is insufficient or even slightly adverse.

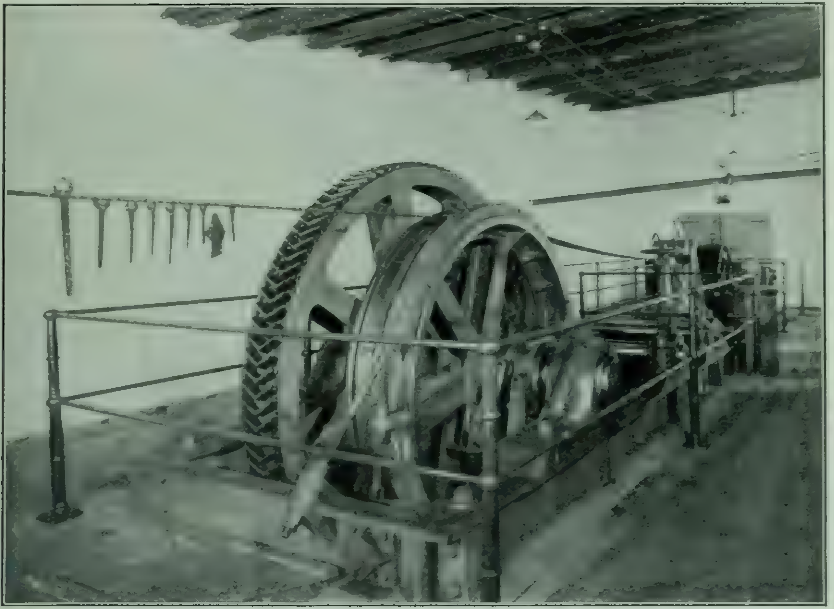
Rope haulage can be made far more effective, and its output can be greatly increased, by using double lines of rails and an endless rope moving at comparatively low speed. Such a line travelling at say two miles per hour can work on any grade up to 30 or 40 per cent., and can carry single cars spaced as close as 50 feet, or small groups of cars at correspondingly greater distances, and under these conditions will handle one hundred cars per mile, or say 400 tons per hour. In practice the rope can seldom be so uniformly loaded as to give this result, and there are always occasional stoppages of the whole line caused by interference at junctions. In spite of these causes, many plants average 200 or 250 tons per hour in regular service, and 3,000 tons per shift of ten hours has been exceeded.

The cars are attached to the rope by ties or clips, the latter often being so arranged as to release automatically at the terminals. The speed is so low that empty cars can easily be released and switched by hand at junction points, and loads similarly run in and attached.

The great advantage of this rope system is the certainty and regularity with which it delivers loads to the hoisting plant and removes the empties, thus rendering it possible to hoist under the most favourable conditions. The low speed also insures a minimum of derailments and other accidents, and when these do occur they are far less likely to be serious than with any of the other systems.

A JUNCTION ON A HAULAGE PLANE, SOUTH STAFFORDSHIRE, ENGLAND.

The first cost of an endless-rope system is probably greater than that of any other haulage, for not only is the plant itself costly, but the roadway has to be made wide enough for double track, or driven double when the roof will not permit of this. The operating costs are also comparatively high owing to the wear of the rope and rollers, and to the heavy losses from friction, which become excessive on long and especially on crooked lines with many curves. The system is, however, so eminently satisfactory in many other respects, that it still finds many advocates even for cases where electric or other independent motors are practicable, and for roadways which have heavy grades it is still the only proved system.



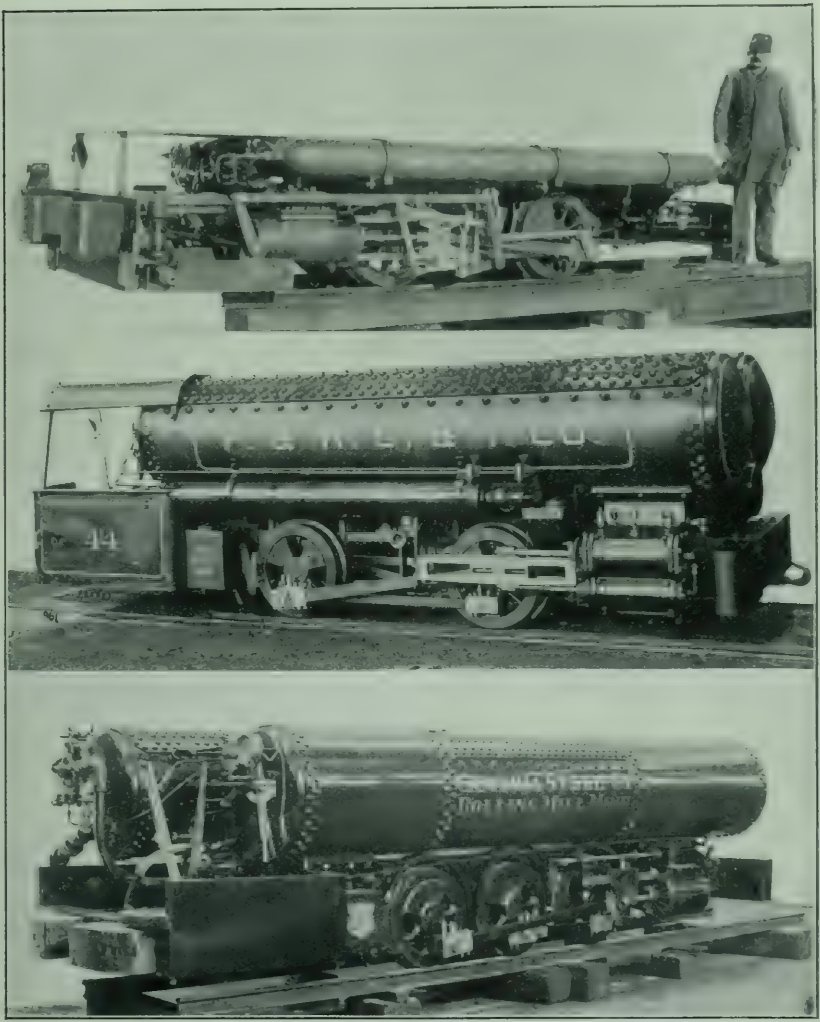
ELECTRIC-DRIVEN ENDLESS-ROPE HAULAGE GEAR, CAROLINE PIT.
Driven by an electric motor of 90 brake horse power, with Hall friction clutch gear. By Ernest Scott & Mountain, Ltd., Newcastle-on-Tyne.

Haulage ropes are sometimes led to the surface, and there driven by steam engines or other motors, but ordinarily the drums or driving sheaves are placed underground near the home terminus of the line. They were formerly almost exclusively driven by geared steam engines, and this method is still frequently employed, but the transmission of steam down the shaft is always wasteful and in some cases dangerous. In a number of plants, rope transmission from the surface has been found satisfactory, but in recent installations, especially in England, electric motors have been largely used.

Slope haulage and auxiliary rope lines at a distance from the shaft were usually driven by compressed-air motors or by some connection with the main haulage ropes. In many cases the bore holes are now used, giving direct rope connection with the surface, but the most common practice at present is to employ electric power. For this service both direct-current and induction motors have been found quite satisfactory. The former are probably more economical when not too far from the source of electrical power, but the latter permit of cheaper and more efficient transmission to long distances and are practically sparkless, a condition of the utmost importance in mines troubled with explosive gas.

In the United States, where most of the coal comes from large seams, and where faults and irregularities are fewer than in less favoured places, the use of independent motors has become very common during the last few years. With certain special exceptions, these motors cannot work to advantage against grades of over 4 per cent., or with grades more than double this, but under favourable conditions they afford the cheapest haulage of the present day. Steam locomotives were the first to be used, and colliery statistics show them still to be very numerous in mining work, but most of them are employed either on the surface or on lines chiefly above ground, and comparatively few are now continuously employed in underground service because of their interference with ventilation and of the increased risk of fire. At best they are only adapted to use in main roads which are large and close to the surface, and even there it is necessary to exercise great care to prevent accidents due to asphyxiation and carbonic-oxide poisoning. Electric and pneumatic locomotives, on the other hand, are admirably adapted to underground service, and within the last decade both types have been so developed that we now have a number of excellent machines in each of several classes,

HAULAGE SLOPE AND TIMBER YARD, WESTVILLE-PICTOU CO., NOVA SCOTIA.

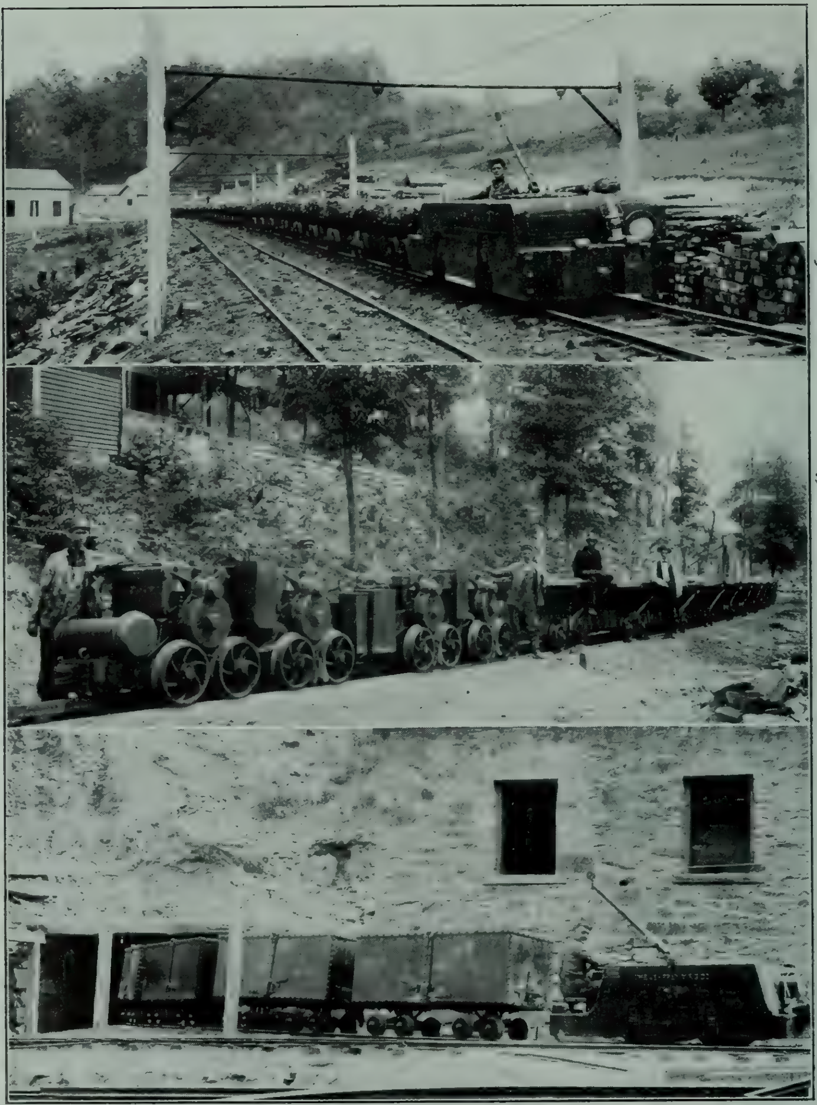


TYPICAL COMPRESSED-AIR LOCOMOTIVES FOR MINING USE.

The topmost is made by the Dickson Locomotive Works, Scranton, Pa.; it is for 3-ft. gauge, and is 35 in. high above the rail and weighs 13,100 lb.; 700-lb. storage pressure, 125-lb. working pressure, 3,080-lb. tractive power; 7-in. cylinder, 14-in. stroke. The middle picture shows an air locomotive from the Baldwin Locomotive Works, 3-ft. 8-in. gauge, weight 21,880 lb.; cylinders 5 and 8 in. by 12 in. The locomotive at the bottom is made by the H. K. Porter Co. for the Cambria Steel Co.'s mines. It is 3-ft. gauge, 5-ft. 3¾-in. high, and weighs 27,000 lb.; tanks 16 and 18 ft. long, 33 in. outside diameter; pressure 700 lb.

and where the grades are not too great, train haulage with these motors compares very favourably with the best work done by ropes.

In most mines large enough to have power haulage, the shaft or entry and certain main roadways are comparatively permanent,



ELECTRIC MINE LOCOMOTIVES IN SERVICE.

The uppermost picture shows a locomotive built by the Baldwin Locomotive Works, and in service at the Eureka Mines of the Berwind-White Coal Mining Co. Two 50-horse-power 500-volt motors. Weight 26,000-lb., starting draw-bar pull 5,200 lb. The middle one represents a third-rail electric locomotive by the Morgan Electric Machine Co. at the mines of the Collins Colliery Co., Glen Jean, W. Va. The lowermost picture is taken in the Lake Superior iron region and shows an ore train pulled by an electic locomotive made by the Jeffrey Mfg. Co.

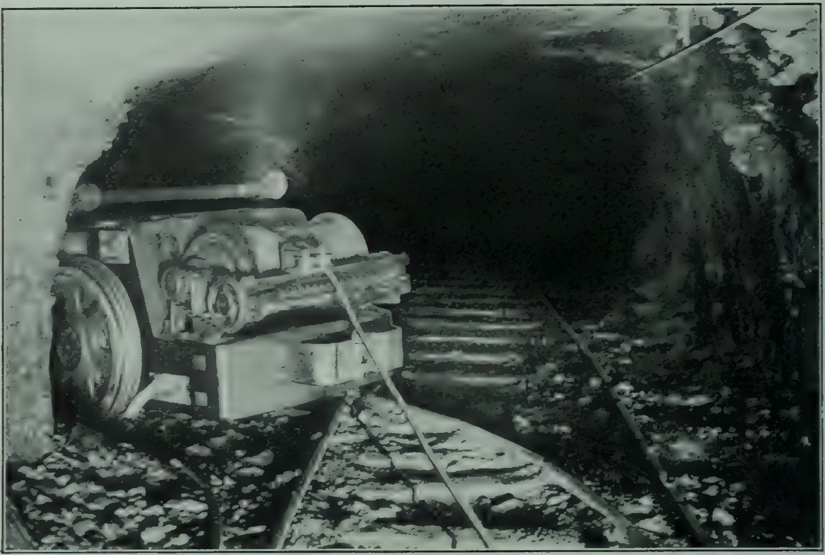
and can properly be made of such size, and with such grades and curves, as will ensure rapid and economical transportation; but even

STEAM MINE LOCOMOTIVE, ELKHORN COAL & COKE CO., MAYBURY, W. VA.
44-inch gauge, cylinders 10 by 14 in., boiler pressure 150 lb., tractive force 6,375 lb.; weight about 30,000 lb., height above rail 5 ft. 6 in. Built by the H. K. Porter Co., Pittsburg, Pa.

in these main arteries of the mine, the dimensions of the headings must be kept down as far as is reasonably possible in order to lessen first cost and maintenance expenditure. These roads cannot in the nature of things extend quite to the working places at best, and ordinarily the actual mining operations are carried on at considerable distances from them, and cars, whether loaded at the face or at batteries or chutes, have to travel over long stretches of rough track in the workings and through narrow, tortuous, and more or less temporary lines of communication to the nearest points on the main road.

These conditions obtain whether we use rope or motor haulage, and until recently the universal practice has been to employ horses or men for this secondary service of handling the cars between the loading places and the nearest main-road points. With the independent motor, however, the advantage of being able to run out into the workings is so obvious that efforts have been made to produce machines which could work on poorer tracks and sharper curves than are permissible on the main line, and thus to reduce the secondary haulage as far as possible. Pneumatic locomotives have been particularly successful for this service, as they are independent of trolley connections, and need only a practicable line of rails. They also have the advantage of being absolutely sparkless and thus safe in the most gaseous places, and of having approximately maximum efficiency through a wide range of speeds.

They even aid somewhat in the ventilation. Their disadvantage is that they can carry but a limited supply of compressed air, and therefore have to return to the supply pipes at comparatively short intervals. They are also very bulky as compared with steam or electric motors of equal tractive force, on account of the comparatively large size of even such tanks as are necessary to carry air for a single trip of any extent. Compressed-air machines are also of comparatively low efficiency, and although this objection can be greatly lessened by reheating with superheated water, this again increases the bulk of the machine.



2½-TON ELECTRIC GATHERING LOCOMOTIVE WITH CABLE REEL, EMERGING FROM A ROOM INTO A MAIN HAULAGE ROAD WITH A LOADED CAR.

Jeffrey Manufacturing Co., Columbus, Ohio.

Electric locomotives are very compact and flexible as compared with the other two types of independent motors, but of course have to remain in constant connection with the service wires. Fortunately trolley wires cost little to erect and a comparatively short term of service will justify their use in a secondary line. The difficulty of reaching the rooms still remains, but this is now being met by the use of flexible cables wound upon reels carried by the motors themselves. These cables are not used in the ordinary main-road service. but, when a motor wishes to leave a line and run into the rooms, the cable is connected with the main wire, and is paid out as the motor travels further into the mine. By an ingenious device sufficient tension is always kept on the reel to prevent excessive unwinding and kinking, and when the direction of the motor is reversed the reel automatically draws in its cable. These gathering locomotives are as yet too new to be spoken of with absolute certainty, but there is every reason to feel hopeful that they, or some equivalent device, will make electric traction perfectly practicable to the very face of the workings in all mines which are not too gaseous.

THE UPPER PICTURE SHOWS ENDLESS-ROPE HAULAGE AT SEATON DELAVAL COLLIERY; THE LOWER, ENDLESS-CHAIN HAULAGE AT A COLLIERY IN THE MIDLANDS OF ENGLAND.

As far as colliery haulage goes, we may perhaps take the present state of affairs in the United States as an indication of the probable future practice in mines in which the size and slope of the coal renders independent motors practicable. The deepest and most gaseous mines in the country are those of the Pennsylvania anthracite regions. In these there were, in 1903, 71 pneumatic and 84 electric locomotives in use, the latter presumably in the less dangerous mines. In the Pennsylvania bituminous regions there were 23 pneumatic and 435 electric locomotives, and in the rest of the United

SLOPE AND TIPPLE FOR ENDLESS-ROPE HAULAGE, DOMINION COAL CO., GLACE BAY, N. S.

States and all Canada, as far as figures are available, there were about 60 pneumatic against 1,500 electric machines.

Another danger from the electric locomotive is the bare trolley wire or third rail, which cannot always be kept out of reach and which no regulations will keep men from touching. I can state from personal experience on several occasions that 220 volts direct current may be taken on the head and even through a pair of gold spectacles without fatal results to a man of ordinary strength. Nevertheless a number of miners, presumably men with weak hearts, are killed each year by such low voltage, and higher pressures or alternating currents are of course more dangerous. Accident reports show, however, that almost as many men are killed, and vastly more are injured annually by being kicked or bitten by horses and mules, and these amiable animals have the added disadvantage underground of fouling the air to five or six times the extent of an equal number of men. Stables are also responsible for a considerable percentage of all serious mine fires.

Thus far little has been said about the cost of mine haulage, and it is impossible to give any figures comparable either for accuracy or general applicability with similar figures for surface transportation. Mine tracks at their best are rough. Another disadvantage is that the traffic is concentrated at one end of the line only, and that it is distributed at the other among a large number of sub-stations, thus involving irregular and uneconomical train service. In spite of these difficulties, the actual ton-mile costs have been reduced to very reasonable figures, some of which it may be interesting to give.

Human haulage or tramming as practised so largely in metal mines, and somewhat in collieries, is very costly—averaging certainly above 20 cents per ton mile and often far exceeding this. Even power haulage is costly for the short distances common in metal mines, but wherever the traffic is at all heavy, it is far cheaper than tramming, and the recent rapid extension of electric and even rope haulage in Michigan and the West shows that managers are beginning to appreciate this fact. Horse haulage ranges between 2 cents and 20 cents per ton mile, but probably averages about 8 cents. Rope haulage on level roads costs about half as much—probably 4 cents is a liberal estimate—but when employed on steep grades it is more costly as it combines hoisting with haulage proper. Electric and pneumatic haulage are both cheaper than the older systems, and both have shown extremely low costs, reaching say 1½ cents per ton mile in certain special cases; but these extreme figures cannot be properly compared with those given above for horse and rope haulage. It is safe, however, to say that, in services to which they are adapted, pneumatic locomotives are at least as cheap as endless rope and have the advantage of independence, while electric motors are probably one-third cheaper in the average than rope and appreciably cheaper than pneumatic.

This paper has been devoted chiefly to a discussion of American practice, partly because the author is more conversant with American mines than with any other, but chiefly because the great mines of America are of such a nature, and have been developed under such conditions, as to give every facility for the rapid and successful introduction of the most modern devices and methods.

A new mine on a thick and reasonably level seam can often be equipped throughout with the most modern electric or pneumatic machinery, including a system of haulage reaching from the entrance to the very working places, and such a mine will of course show extremely low operating and transportation costs. On the other hand, deep mines in troubled ground can seldom be arranged for any one system, and in many cases several different systems of haulage have to be fitted together into one harmonious, if complex, whole.

If instead of a new mine we take the case, almost universal in England and common enough in America, of an old and extensive mine already provided with reasonably effective transportation, the matter is still more difficult, and the manager of such a mine is usually fully justified in holding to the old methods in general, although he should of course make every effort to increase their efficiency by the use of modern appliances whenever practicable.

POWER GENERATION AND TRANSMISSION FOR A MODERN MINE.

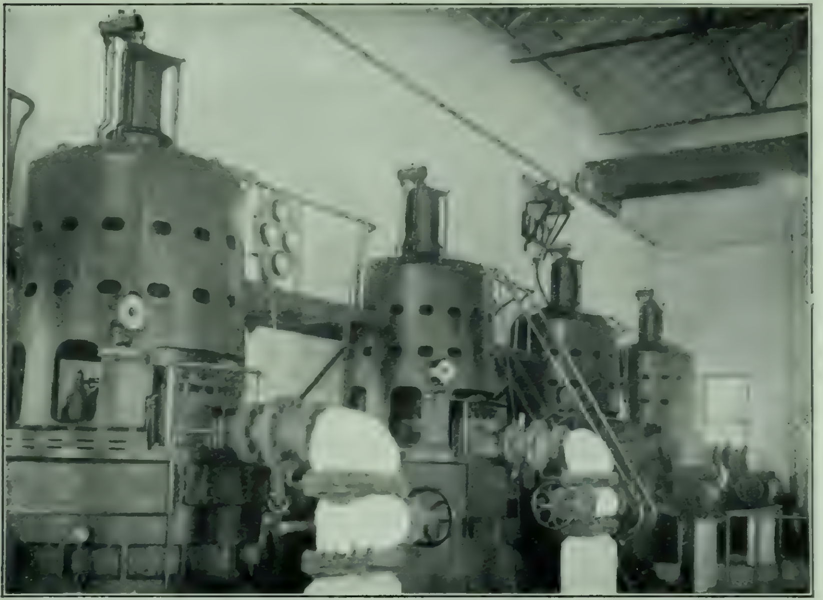
By E. H. Roberton.

While the power applications in the mine are highly specialised, the generating plant proper is of course essentially like that employed for other large undertakings. Mr. Roberton therefore confines himself to such points of distinction and difference as are to be noted, and does not attempt the enormous, and in this place needless, task of reviewing power plant in general.—The Editors.

THE question of power generation and transmission opens up a more extensive field of possibilities and uncertainties to the miner than perhaps to any other class of engineer. The costly plant that may have already been in operation some time, the possibility of introducing a factor of danger into works so far comparatively free from it, and the uncertainty in the case of electricity at least of future legislation that may nullify or hamper the good effects of a new and expensive equipment—all these are bound to exercise a deterrent effect on the engineer who meditates a new departure in the generation of power.

Speaking with reference primarily to existing British practice, in coal mines, as is natural, steam is almost universally used for power generation, while in slate and metalliferous mines, situated as they often are in hilly and well-watered districts, water power is the rule. In the latter the old-fashioned water-wheel, coupled direct onto shafting, which proves to be so great a nuisance in frosty weather, is rapidly being replaced by the hydraulic turbine, or the Pelton wheel, in conjunction with a dynamo generating electrical power for distribution to the various machines. In the former the change is much less rapid, and there is much debate as to what method of transmission of power will prove of the greatest utility.

An alternative for the generation of power in coal mines, specially suited for such districts as the Black Country where there are many spoil heaps consisting almost entirely of rejected small coal, or for such mines as draw out of their shafts quantities of unsaleable slack, is the manufacture of producer gas from the slack, and the generation of electricity by means of gas engines. Or the same slack might be turned to use in boilers in conjunction with forced draught, and electrical power distributed for use throughout the district. The latter system is in practical use at Wallsend, supplying electrical power to the district around Newcastle-on-Tyne, and has proved very success-



A MODERN CENTRALISED MINE POWER PLANT. HAMPTON CENTRAL STATION, D. L. & W. R. R.

Five 500-k.w. Curtis vertical turbines, driving three-phase 60-cycle 2,300-volt General Electric alternators. The current is stepped down at mine sub-stations to 275-volt direct current, by rotary converters, and the power used for haulage, slope work, pumps, etc., over a radius of about three miles. The illustration was secured by the special courtesy of Capt. R. A. Phillips.

ful, so much so that additional similar central generating stations have been proposed to supply power to other colliery districts in the same part of the country. Such is, however, the thermal efficiency of gas engines using producer gas, that it is probable far better economic results would be obtained in central stations employing the latter.

The general impression produced by an inspection of the mines in Great Britain is that for the most part they are in a transition state in regard to power distribution, so many and varied are the methods employed, even over a narrow area. In one group of collieries known to me, both electricity and gas were used for lighting purposes; ventilation was effected by steam power and by furnaces; haulage was by steam and animal power; underground pumps were worked by transmitted steam, rope transmission, and an oil engine, and an experimental plant for coal-cutting by electricity was fitted up. In a neighbouring colliery compressed air was used for coal-cutting and underground haulage, while again in another electricity was used for the same purposes. Such a heterogeneous collection of power, spread over a comparatively small area, although it is the natural growth of years, cannot lead to the very best economical results; but whether all these collieries will ultimately combine to use the same power for all purposes, drawn from a central station, time alone will shew.

In all mines the broad lines of choice for transmission of power, either over the surface works or underground, lie between steam, hydraulic, rope, compressed air, and electrical transmission; and a thorough invstigation of the conditions to be met with, and of the effects required, must be instituted in each particular case, before choice can be made of the most suitable mode of power distribution. The conditions which differentiate mines from other classes of works in which transmitted power is required, may be briefly summed up as:—the necessity of carrying power down a shaft which is probably very damp, and through which there is a strong current of air constantly travelling; the long and tortuous ways through which it must be guided; the constant passage of men and animals, rendering necessary extra precautions against accident to life and limb; the possibility of injury to pipes or cables from falls of roof and sides; the comparatively rapid progress of the workings, especially in a thin seam of coal, necessitating devices for a continual increase in the distance through which the power is transmitted. All these conditions, which in themselves vary widely in different mines, must largely influence the engineer in his choice of power.

As was to be expected, when labour-saving appliances were gradually making their way into favour, mining engineers chose the methods that were easiest in adaptation to existing plant and that cost least money to install. Such methods as pipe transmission of steam, rope transmission of power, and hydraulic pumping, were therefore the first that came to hand, as no special generating station was needed, and an old engine often sufficed for each purposed application of power. The idea of a generating station for the supply of power for all purposes was not thought of, or if thought of was dismissed, as the different appliances for the saving of labour were not all added at one time, but often separated by long periods of years.

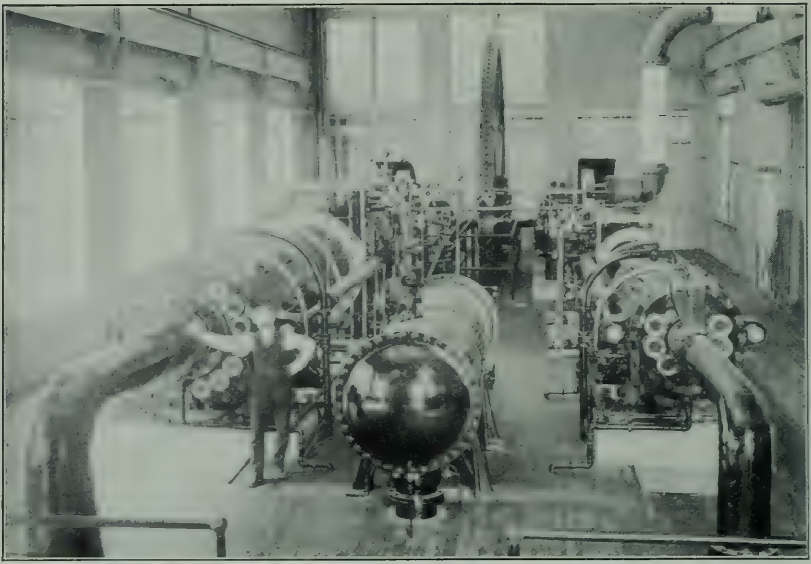
It is never wise to attempt to transmit steam in pipes through any considerable distance. Condensation and consequent loss in efficiency will take place, however carefully the pipes may be covered with non-conducting material; and in mine work, especially in the working shaft, any part of the steam pipe which may have become stripped has often to wait a long time for repairs, little notice being taken so long as the engines below ground are kept running. Mining engineers are just waking up to the fact that an accumulation of small losses like this means in the year an appreciable diminution in profits, and corresponding efforts are being made to reduce such leakage of power in working practice. The superheating of the steam enables it to be transmitted through pipes to a greater distance than is practicable in a saturated state, but even then not to such an extent as to warrant its transmission through any considerable length. In cases of necessity, however, superheating is an advantage, besides being in itself a source of economy in the working of steam engines. Too much anxiety should not be shewn to increase the efficiency of the pipe transmitter by superheating, as an overabundance of superheat is very injurious to the working parts of engines that are near the superheater, and speedily makes its effects apparent.

To demonstrate the effects of this appliance on the condensation of steam in pipes, the experiments made by Mr. Leach of Seghill Colliery are very apt. Dixon superheaters were fitted at the colliery a few years ago to a battery of five boilers, and whereas formerly 29.4 pounds of water per 100 square feet of pipe was collected from the steam pipes and traps, after the fitting of the superheaters to the boiler plant this quantity was reduced to 12.8 pounds. As an illustration of the economy effected, superheating has enabled Seghill colliery to be worked by three instead of four boilers, while still burning the same quality of small coal.

The limit of practical transmission of steam in pipes has probably been approached at Broomhills Colliery, Northumberland, where steam is conveyed to an underground pump 1,414 yards from the boilers. The drop in pressure is 13 pounds, and the loss by condensation 21.06 per cent.

As above mentioned, water, while used largely in slate and metalliferous mines for the production of power, relies on electricity or compressed air for the distribution of the power it has produced. As a transmitter of power, water has practically only one field of utility in a mine, viz., the pumping of water by means of a hydraulic pump to the main pumps, from a district lying to the dip. The high-pressure water for this purpose is led straight from the rising main to the hydraulic pump. Water is occasionally used to work hydraulic rams for the purpose of loading and unloading the cages, and for similar work, and in at least one instance for conveying coal some considerable distance through a large pipe.

Although in its main features there may at first sight seem but little reason why the power-generating station for use in a mine should differ materially from that which is designed to serve other utilitarian ends, such as the propulsion of cars or the lighting of a city, a little reflection will shew that if we confine our sphere of opera-



AIR-COMPRESSOR PLANT, HOMESTAKE MINE, LEAD, SOUTH DAKOTA.

Cross-compound Corliss type; steam cylinders 32 and 60 in., air cylinders 52¼ and 32¼ in., stroke 72 in.; 50 revolutions, 9,000 cu. ft. free air per minute, sufficient for 125 rock drills with steam at 125 lb. Several smaller compressors of the same make are installed. Ingersoll-Sergeant Drill Co., N. Y.

tions to one mine, considerable modification must be made in plant that would otherwise be suitable for propulsion or lighting. Taking a single large colliery:—it is probable that there exist few other works of similar extent in which the demand for power is so variable. In the pumping and ventilating alone do we find a uniform expenditure of power. All other engines, in point of size and importance, give way to the winding engine, which, especially in a deep mine, consumes a very large percentage of the total power generated. This engine creates at the beginning of every trip a demand for power which is greatly in excess of what it needs during the latter part of the trip, and this lesser demand is in its turn succeeded by a period of no demand. Again, breakdowns in the underground haulage system, and consequent spells of enforced idleness on the part of the winding and hauling engines, are fairly frequent, as is only to be expected in workings that are subject to unexpected falls of roof or sides.

In ordinary generating stations, such as would be designed for power-supply to large towns or railway companies, the favourite type of engine is probably the triple-expansion marine type, which is so constructed as to be eminently suited for economical working so long as the output is practically constant. The boilers are usually either of the water-tube or cylinder marine type. The efficiency of these plants compares with that of the best marine practice, the steam consumption of which approximates to 2 pounds per indicated horse power per hour. When it is stated that the corresponding steam consumption of an ordinary colliery winding engine has been variously estimated at from 70 to 120 pounds, it will be seen that there is considerable scope either for the introduction of steam-economising appliances, or for a radical change in existing methods. The former have been for some years past in use in many mines in Great Britain, both in the form of feed heaters and steam superheaters. These justify their existence in that where they have been used they have certainly saved more than their cost and upkeep, but in themselves they are insufficient to work the good that could be wrought in conjunction with the latter.

If we extend our field of view, and include not one mine only, but a series of mines covering a broad area, a temporary stop at one mine will not affect the others, and the general effect will be a fairly uniform expenditure of power, and the more mines we include, the more uniform will the power expenditure tend to become. Practical application, however, involves the abandonment of existing steam plant which might otherwise have a long life before it, and the substitution of expensive leads and machinery for the distribution and utilisation of power, the effecting of which must be a gradual process and cannot but occupy a long period of time.

The type of engine most in favour in mine works for the purpose of power generation is the horizontal type, simple in the earlier, and compounded in the later examples. A typical instance is the electrical plant recently laid down for the Weardale Coal Co. This plant generates electricity for underground pumps dealing with a flow of 1,200 gallons per minute, against a head of 650 feet, and consists of a compound horizontal steam engine of 600 horse power, driving by means of ropes the dynamo, whose output is 400 kilowatts. The generator is of the continuous-current type, having a central driving pulley, by which arrangement either half of the machine may be worked separately. A plant of larger size is that at the Staveley Coal and Iron Co.'s works, where the aggregate horse power of the power-generating stations at the five collieries is 3,500, most of which is employed in operating polyphase induction motors situated in all parts of the mines, surface and underground. A modern plant of a most comprehensive type is that installed by the United States Coal and Coke Co., which consists of two cross-compound engines of 1,200 horse power each, driving two 750-kilowatt 6,000-volt generators, with a 50-kilowatt exciter set. There are four additional sub-station equipments, and nine induction motors for driving fans and pumps; also five mine locomotives, and sixteen electric motor outfits for coke oven larries. In the Homestake mine, Black Hills, South Dakota, is a fine air-compressing plant, supplying power to the motors driving the ore trains. Besides this, in the rock beneath the floor of the hoist is a huge excavation, 75 feet by 35 feet, for one of the largest air-compressors yet built by the Ingersoll-Sergeant Co. The duty of this plant consists in operating 125 rock drills, and a battery of eight 200-horse-power boilers is required for its working. (See page 648.)

Choice of power transmission depends on initial cost, cost of working and keeping in repair, and efficiency. In mine work the last item must be taken in its broadest sense, including not only a fair output of power for a given coal consumption in the boilers, but also the ability to overcome when necessary—and not infrequently—a resistance greater than the average. For this end the whole of the plant, generator or compressor, conductors, and motors, should be "well up to" their work, a phrase that in mining parlance means roughly anything up to 50 per cent. ahead of it. Naturally, in point of efficiency as efficiency is usually considered, such a plant does not compare with one that is designed and laid down with a view of an assured uniform output, but under conditions such as obtain in ordinary mine work ensures the cost of upkeep and repairs being kept within bounds. So far as actual efficiency in transmission is concerned over ordinary distances, electricity is preferable to compressed air, though the difference becomes less marked as the distance of transmission becomes greater. On the other hand, compressed-air motors are generally simpler to understand and repair than electrical, and the fitting in of spare parts can easily and cheaply be effected in the mine. The joints of compressed-air mains, however, are liable to leakage, and the splitting of the main into several channels is not so simple a matter as in the case of electricity. A useful combination is often resorted to. Electricity is transmitted into a mine so far as is thought convenient or safe, and at this point an electrical air compressor is placed, which supplies power to machines situated further in the mine. Thus two purposes are served. The economical transmission of power by electricity is effected, and the use of compressed air is secured in parts of the mine that might threaten danger to the use of electricity, or in machines that do not adapt themselves to electrical power.

The extensive use of electricity underground in mines, especially in coal mines, is largely limited by the fear of accidents arising from its use, which may involve serious expense if not loss of life. The main cables must pass down the shaft and along galleries in which the available space is necessarily limited, and the permanence of the cable insulation constantly threatened both by atmospheric conditions and by possible falls of roof and sides. Other incidents, too, which are inseparable from the use of electricity, may under certain conditions prove a source of very grave danger. The occurrence of a spark in a suitable mixture of gas and air would cause an explosion, and although enclosed motors may be used, it is possible that rough usage received in the mine may impair the efficiency of the air-tight chamber, in which case the feeling of security engendered by its use may prove the greatest source of danger. It has been suggested as additional security, to keep the air-tight chamber full of carbonic-acid gas.

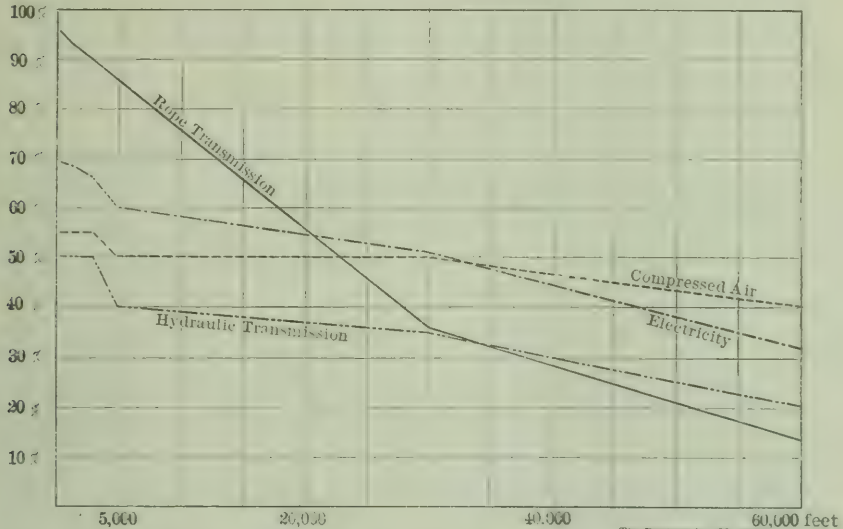


DIAGRAM SHOWING COMPARATIVE EFFICIENCIES OF VARIOUS METHODS OF POWER TRANSMISSION THROUGH VARYING DISTANCES. (BERINGER.)

Armouring the cable is commonly practised in order to save the insulation from small damages, but in case of an injury piercing the insulation a flash results before the fuses blow. If the cable is unarmoured there is no flash, but unless the leakage is detected smouldering may result. The insulating material for mine cables should be flexible and waterproof, and durable under varying conditions of atmosphere and temperature. A substance that has found much favour in mining circles is that known as dialite, a species of vulcanised bitumen. A feature that especially recommends it to miners is the ease with which a damaged portion can be repaired. The insulation is cut away for a few inches on each side of the injured part, and a fresh lapping made, which can be vulcanized *in situ.*

On October 16, 1902, a departmental committee was appointed by H. M. Home Secretary, to enquire into the use of electricity in coal and metalliferous mines, and the dangers attending it, and to report what measures should be adopted in the interests of safety by the establishment of special rules or otherwise. This committee concluded their enquiry in May, 1903, and submitted as their finding the following four general principles which should govern the employment of electricity in mines:—

> 1.—The electric plant should always be treated as a source of potential danger.
>
> 2.—The plant, in the first instance, should be of thoroughly good quality, and so designed as to insure immunity from danger by shock or fire; and periodical tests should be made to see that this state of efficiency is being maintained.
>
> 3.—All electrical apparatus should be under the charge of competent persons.
>
> 4.—All electrical apparatus which may be used when there is a possibility of danger arising from the presence of gas, should be so enclosed as to prevent such gas being fired by sparking of the apparatus; when any machine is working, every precaution should be taken to detect the existence of danger, and on the presence of gas being noticed, such machines should be immediately stopped.

In addition to the above, the committee drafted a list of special rules which they thought might with advantage be introduced into all mines. These, however, have not met with approval amongst the leaders of the mining industry. It is a well-nigh impossible task to draft a set of rules governing the use of electricity which shall be applicable to the varied conditions to be met with in the coal and metal mines of Great Britain; and further, the introduction of any rule granting, for instance, an arbitrary power to a district inspector of mines to place a veto on the existing method of electrical employment or transmission in any portion of a mine, would tend to extra diffidence and caution on the part of the management in placing orders for a new installation on a large scale. And they are cautious enough already! It should be sufficient to allow the mining engineer the same latitude of judgment as he already possesses in the matter of the installation of compressed-air or steam plants, knowing that he is directly responsible for the safe and efficient working of all apparatus under his charge, and for his own sake will not be likely to employ any agent that may create a tendency to danger in the conditions obtaining in his mine.

THE DEVELOPMENT OF ECONOMY IN RAILROAD TRANSPORTATION SINCE 1875.

By S. Whinery.

The railway was one of the first mechanical-transport agencies to attain commanding importance. It remains one of the most impressive, and perhaps the most influential of all, today. It seems appropriate, therefore, to sum up this number by a review of the advance in economy in railway transportation which has accompanied the other developments studied in preceding articles. We are especially glad to have placed this closing article in the care of one who has himself taken so active a part in the extension of American railways and in their betterment.—The Editors.

THE writer who, in a single magazine article, attempts to delineate the progress of railroad development during the last generation, must necessarily work with broad lines and scant attention to detail. But he is confronted by the fact that the history of this important department of our industrial activity during that period is mostly a history of details. Wonderful as has been the development and expansion of our railroad system since 1875, there have been no epoch-making discoveries or improvements in railroad construction, equipment, or operation. Progress has been rather through the gradual but unremitting development and improvement of the theories and appliances that were then already familiar in the railroad world.

In 1875 our railroad system was not yet half a century old. At the beginning of the preceding generation (1843) there were only 4,185 miles of railroad in the United States. But that generation was one of unparalleled activity and expansion, not only in the growth of the railroad system, but in the development and application of the fundamental principles of railroad transportation and of the physical plant best adapted for the requirements of the business.

In 1875 the necessity for better permanent way, for lighter grades and easier curvature, for more powerful and economical locomotives, for cars of greater capacity, and for improved operative methods, was understood and appreciated. Steel rails had already been introduced, and modern standards of track construction and maintenance were coming into use; the leading types of our present locomotives were already in service; cars differed from present practice mostly in their lesser size, strength, and capacity; the sleeping car was in successful operation, and the refrigerator car was not unknown; the air brake had been developed and largely applied to passenger equipment, and its later use on freight trains was foreseen and predicted; the prototypes of our present signaling systems had appeared, and the methods of train operation now in vogue, were in process of development. On the economic side the disastrous effects of unbridled competition had already become manifest, and able minds were engaged upon the problem of controlling it within reasonable limits; and projects for consolidating connecting lines into systems under one management were being cautiously worked out. In short, the foundation and framework of our present railroad practice had been so successfully established that the succeeding generation has been devoted to developing and perfecting the superstructure.

Railroad transportation being a commercial business, the ultimate object of those engaged in it has been to make it profitable, or, in other words, to increase earnings and cut down expenses. Actually, the problem has been largely how to reduce the cost of railroad transportation. Upon this problem has been engaged the ablest body of men that any country has ever marshalled in any single calling. They have labored with a devotion and unity of purpose, the like of which it is hard to match in the history of the world. They have not worked singly and independently, but unitedly through systems of organization that are themselves unparalleled outside of military history and discipline.

In 1875 there were 74,096 miles of railroad in operation in the United States, together with probably from 15,000 to 16,000 miles of sidings, second and other subsidiary track. In 1903 the number of miles of railroad operated in the United States was 207,784 and the number of miles of subsidiary track was 79,376. The mileage of track was thus, in twenty-eight years, multiplied by three.

Improvement in railroad transportation has not been confined to any one department of the business, nor has it been especially more marked in one department than another. Permanent way, equipment, and operation are necessarily so intimately related to each other that they must advance concurrently and harmoniously or not at all. Without increased strength and stability of track and other permanent-way structures, the employment of the present heavy rolling stock and high speeds would have been impossible, and without improved operative methods, improvements in permanent way and rolling stock would have proved largely futile.

Reviewing briefly the measures and steps by which this result has been achieved, we may begin with the essential foundation of the modern railroad—the permanent way. From the mechanical point of view the cost of hauling a car over a railroad is affected by two elements; the resistance to movement of the car, and the efficiency of the locomotive. Upon a straight and level track the power required to move a car need be sufficient only to overcome the friction of wheels upon rails, of car journals in their boxes, and the resistance of the air. To reduce to a minimum the frictional resistance between the wheels and rails requires that the rail shall have such strength and rigidity that it will not yield under passing loads, and that it be firmly supported by the substructure of the track.

The substitution of steel for iron rails, which took place rapidly during the earlier years of the period we are considering, and which was greatly accelerated by the rapid decline in the price of steel, was one of the most important advances in modern railroading. In 1875 the market price of Bessemer steel rails was $75 to $80 per ton; in 1880 the price declined to about $65, and at the present time it does not exceed $28 per ton. One of the contributing causes of this rapid decline in prices was the general adoption about 1893 of standard rail sections. Previous to that time, when many of the roads demanded rail sections of special design, the variety of forms called for was very great, and as special rolls had to be provided for each different section, more or less delay and increased cost resulted. To-day about three-fourths of all the rail produced in the United States conforms to the standard then adopted. As the weight of locomotives increased, heavier and stronger rails became necessary. In 1875 very few rails weighed over 60 pounds per yard; to-day the weight ranges from 80 to 110 pounds per yard. These changes called for a corresponding improvement in other track appurtenances. Heavier and stronger rail joints were provided, the quantity and quality of ballast was increased, more attention was given to drainage, and greater care was taken to place and maintain the rails in good line and surface. The substitution for wood, first of iron and then of steel, in the construction of railroad bridges, developed very rapidly, and important improvements in the general design of these bridges were made in the early part of the period. Concurrently, improvement was made in the form and tread of car wheels and in the dimensions, workmanship, and means of lubrication of axle bearings. All these improvements resulted in a considerable reduction in the frictional resistance of rolling stock, as well as in reduced cost of maintenance.

But only a small part of any railroad line can usually be straight and level, and any departure from that condition introduces other and very important elements of resistance—curves and gradients. As is well known, the resistance offered by curves varies with their radius and length, while that of gradients varies as the steepness of the incline. To move a ton on straight and level track may require a pull of from 7 to 10 pounds, and a curve having a radius of 400 feet may double the power required. To move a weight of one ton up a gradient of one per cent requires a pull of 20 pounds regardless of frictional and curve resistance, so that a gradient of one-half of one per cent, or about 26½ feet per mile, at least doubles the resistance due to friction alone.

The importance of easy curves and light grades, not fully appreciated when the earlier roads were built, became more and more apparent as the business of the roads increased. When it is remembered that with equal frictional resistance, a locomotive will haul three times as many tons with no greater expense over a level track as over one having a gradient of one per cent, the economic importance of light grades may be appreciated. It must be remembered, too, that grade resistance is as immutable as the force of gravity, and that no amount of mechanical skill or operative ability can avail against it. To lift cars to a certain elevation demands a definite quantity of mechanical work, and the cost of this work constitutes a fixed charge on the resources of a road, more inexorable than the interest on its bonded debt. It is not surprising, therefore, that an increasingly large part of the money spent upon our railroads for general betterments in the last twenty years has been devoted to reducing gradients, even to the extent of an entire change in the location of considerable portions of the line. A notable example may be mentioned. The Pennsylvania Railroad between Philadelphia and Harrisburg was originally located and operated without much regard to sharpness of curves and steepness of grades. But as the business of the road grew and the limiting effect of these grades and curves became more apparent, reconstruction and relocation of the line were resorted to and steadily continued, until today not a single foot of the original line remains in operation.

Terminal facilities and appliances for handling freight, which may be mentioned in connection with permanent way, have not only been greatly enlarged and improved, but the introduction of labor-saving machinery has materially reduced the cost of conducting the business per unit of freight handled. This is more particularly true of bulky freight, such as coal, ores, and grain.

Track signal devices may also be appropriately considered in connection with permanent way. The general adoption of automatic signaling systems for controlling the movement of trains deserves to be classed as one of the most important improvements made in modern railroading. If the present practical railroad man were asked what have been the two most important advances in railroad operation in the last twenty-five years, he would doubtless name the application of the air brake to freight trains and the adoption of automatic signaling, since they together have contributed, more than any other improvements, to speed and safety in operating trains.

Improvements in rolling-stock equipment have had two main objects in view; to increase the capacity and working efficiency of both cars and locomotives, and to increase the ratio of paying to dead load hauled over the lines.

In locomotives the most notable development has been in size and hauling capacity. In the seventies passenger locomotives weighing 35 tons and freight locomotives weighing 45 tons were considered notable; to-day passenger locomotives weighing 60 tons and freight locomotives weighing 85 tons are not sufficiently uncommon to provoke comment. The average weight of locomotives has, probably, since the former period, increased from 60 to 70 per cent, and their hauling capacity has increased in a still larger ratio. Regardless of size, the locomotive of today is a much more effective machine than was its predecessor of thirty years ago. Scientific designing and careful attention to every detail has increased its mechanical efficiency in every direction. Among the more notable improvements have been the development of practical forms of the compound locomotive engine, the use of balanced slide valves, fireboxes designed to burn more efficiently the particular fuel available, boilers utilizing more fully the heat of the fuel, more careful balancing of driving wheels, and better designing of every part so as to secure the greatest attainable strength and endurance.

In general design, cars of the various kinds do not vary greatly from the types that were in use thirty years ago. The important changes have been in strength and carrying capacity, in the substitution of iron and steel for wood, and in the development of details. In 1875 the freight car weighed from 9 to 10 tons and carried loads of 10 to 11 tons. Only about one-half the total load of such a car yielded revenue. To-day the average weight of freight cars probably does not exceed 15 to 16 tons and their average load capacity is about 30 tons, while about one-seventh of the box, freight, and coal cars in use have load capacities of 40 tons or more. The more recent standard steel coal and ore car weighs 16½ tons and carries a load of 50 tons, or about three times its own weight.

Perhaps the most important advance that has been made in freight equipment has been the quite general application of automatic air brakes to freight trains, which has made possible much higher speeds and greater safety in operation. Like the nimble penny, it is the active car that brings in a satisfactory revenue. Thirty years ago 12 to 15 miles per hour was considered the highest economical speed for freight trains; today double that speed is considered quite practicable, and through continental trains with perishable freight may average nearly that speed throughout the whole trip. Obviously if a car can be made to make two trips where it formerly made one, its profit-earning capacity must be greatly increased. The quite recent introduction and general application of standard automatic couplers has also promoted higher speeds and greater safety of operation.

One of the most important results of these physical improvements in track and equipment has been the reduction in the relative cost of the human labor necessary for the operation of trains. Reliable statistics upon this point do not extend back very far into the past, but their lesson is interesting. In 1892 the wages paid in the United States to conductors, enginemen, firemen, and trainmen amounted (roughly estimated) to about $128,000,000. The freight handled that year was equal to 88,241,000,000 tons carried one mile, and the passengers equal to 13,363,000,000 carried one mile. If we consider a passenger as equivalent to a ton of freight, the total ton-mileage in that year was 101,604,000,000, and the ton-mileage per dollar expended for wages was 794. In 1903 the sum paid to the same classes of employees was $207,812,281, and the ton-mileage per dollar of wages paid was 934, an increase of over 17½ per cent, notwithstanding the fact that the rate of wages paid had, in the meantime, increased fully 8 per cent. This lower labor cost has been made possible largely by greater train capacity, which in turn has resulted from the improvements to which we have referred. In 1875 the average train load of freight seems not to have exceeded 150 tons, while in 1903 it was 310 tons, so that in that period the average freight-train load has been more than doubled.

The effect of better permanent way and more substantial equipment has had another permanent effect worth noting—the decrease in the cost of maintenance and repairs of equipment. The data for accurate comparison are wanting for the earlier period, but an example will serve for illustration. In 1870 the cost of locomotive repairs on the Pennsylvania Railroad was 9.13 cents per mile run by locomotives, while for the year 1902 the cost of the same item was 6.94 cents. Doubtless something like the same relative reduction in the cost of maintaining other rolling stock has taken place during the period. When it is remembered that the total expenditure for maintenance of equipment on all the roads of the United States for the year 1902 was about $213,000,000, some idea may be formed of the saving that must have resulted.

Turning from the physical to the operative side of the subject, we shall find that improvements and advances in the operation and management of railroads have kept pace with those of track and equipment. Space permits only the briefest reference to this department. The results have been due mainly to better organization, to stricter and more intelligent discipline, and to the simplification and standardization of methods of conducting the business.

At the beginning of the period we are considering the era of railroad combinations had fairly begun. Some of the more important companies had for years been gathering together branch and connecting lines and consolidating them into single systems under one general management. But the gigantic combinations of the present day had not been dreamed of by the public, though they seem to have been vaguely anticipated by some of the far-seeing railroad men of that time. Whatever may be said otherwise of these great consolidated systems, there can be no doubt that they have had an important effect in reducing the cost of transportation, as the result of harmonious management and operation—the subordination of the individual and local interests of the constituent roads to the general interests of the whole system, the maintenance of rates, the avoidance of terminal delays, of complications and expenses at connecting points, and, to a certain extent, a relative reduction in the amount of money paid for wages and salaries. It is doubtful, however, if the last named item is as important as the public seems to believe. While consolidation has dispensed with a large number of general officers, it has been accompanied by an increase in the salaries of those who have remained, commensurate with their larger responsibilities; and the number employed in the lower ranks, never more than the work demanded, has probably not been relatively decreased.

The effect of larger capitalization in the general reduction in cost of railroad transportation cannot be overlooked. In the earlier history of American railroads, when the country was less wealthy and surplus capital was comparatively scarce, it was not always possible to obtain the money with which to make improvements, even when it could be conclusively shown that additional investment might be made to yield better returns upon the whole capital. Railroad managers were compelled to "cut the coat according to the cloth," and the result was often far from satisfactory. Today, conditions have greatly changed. Surplus capital is comparatively abundant and the question has become not so much, can needed capital be obtained, as can it be profitably employed. The management that can demonstrate that an additional dollar can be made to yield good and certain returns, has little difficulty in obtaining that dollar, or any multiple of it. However urgent and profitable have been the physical improvements of our railroads, not so many of them could have been consummated without the bringing in of additional outside capital. As a rule it can be said that additional capitalization has been wisely administered and has resulted beneficially to the public at large.

What has been the net result to the public and to the owners of the railroads of all these extensions and improvements of our railroad system in the past twenty-eight years? The popular belief seems to be that the railroads have reaped the chief benefit, but the facts do not support such a contention. The rates charged for railroad transportation have largely declined and the public has greatly profited thereby, but the returns to stockholders have also declined very materially. Sufficient data are not obtainable from which to determine the average railroad freight and passenger rates in 1875, nor in fact with satisfactory accuracy, at the present time; and space will not here permit the mention of enough illustrative examples to be of value in forming conclusions; but it is probably quite safe to say that, during the period, passenger rates have declined one-third and that freight rates have been practically cut in two.

In 1875 the average revenue derived from hauling one ton of freight one mile on four of the leading railroads of the country was 1.16 cents, and the average for the whole country was probably considerably higher, while in 1903 the same item averaged, for all the railroads in the United States, 0.763 cent, indicating a decrease of about 34 per cent.

In 1875 the total outstanding capital stock of the railroads in the United States was $2,248,358,375, and the amount paid in dividends upon this stock was $74,294,208, or 3.30 per cent. In 1903 their total capital stock was $6,270,032,728 and dividends to the amount of $166,176,586 were paid, an average of 2.65 per cent. being a net reduction during the period of about 20 per cent.

It is true that rates of interest have also materially declined during the period and lenders do not now expect the same returns from capital that they did a quarter of a century ago, but a careful study of all the facts seems to justify the conclusion that railroad investments, whether in bonds or stock, are not relatively more profitable today than they were then.

EDITORIAL COMMENT

PROFESSOR BURR'S important article upon the present aspects of the Panama Canal work, which leads this number, marks a stage in the second great era of progress toward the opening of an interoceanic waterway—the era of actual construction. When THE ENGINEERING MAGAZINE took up the battle, nine years ago, the fight was all against the fatal error—seemingly almost inevitable—of a National commitment to the Nicaragua project, saddled further with the load of the company then exploiting the concession. The course of that battle, the succession of arguments and demonstrations by the foremost engineers of the world which we had the honor of presenting through these pages, and by which public and official opinion and judgment were moulded toward the right decision—these we reviewed editorially not long since. Now that the route is assured, the interest lies in the determination and selection of the best possible plan, and the execution of that plan by the best possible means.

* * *

CONCERNING both plan and means we may well for the present hold an open mind, waiting the completion of the studies now in progress and clearly outlined by Professor Burr. The thoughtful reader will find, in the reflections awakened by the reading of his article, many points suggestive of the great lasting advantage of a sea-level canal. Not the least is the difficulty of anticipating and providing for the requirements of the sea-going craft of even the next few years, in the matter of draft and other dimensions affecting the design of locks. But the difficulties of this decision are by no means evaded by adopting a sea-level plan. The tide lock on the Pacific side, necessary even with a sea-level canal, and the depth of the canal section throughout—what dimensions shall be adopted for them as sufficient for "the largest ships afloat?" How many more years and millions can be wisely spent in the undertaking to free the canal from such restrictions to navigation as would be imposed by locks and a summit level, and what other restrictions would have to be accepted in compensation? We are inclined to think these are the considerations upon which the decision should finally be made; for in spite of much current report, a perfectly safe foundation for the necessary dam can be secured without going to bed rock, if the high-level plan be otherwise deemed the most desirable.

* * *

THE sea-level plan was de Lesseps' ideal, and has been admitted to be the ultimate goal of the project by many of its advocates. And if it is indeed the most desirable waterway for large shipping, it is well to recall to mind now that no sea-level canal could ever have been built on the Nicaragua route. If unfortunately we had attempted the other scheme, and found (as there was every indication we should find) that neither at Ochoa nor elsewhere could foundations be secured for the dam which was the key to the Nicaragua line, the alternative would not have been a greater outlay for a proportionately better result; it would have been the collapse of the entire undertaking, and the loss of everything that had gone into it. And from that disastrous experience we are convinced the country was saved by the patient, persistent, and triumphant fight made for the adoption of the Panama route.

* * *

THE recent meeting of the American Society of Mechanical Engineers in New York proved to be a very satisfactory one, both from a professional and a social point of view. The papers presented, some of which have been noticed elsewhere, bore upon existing and future matters of engineering work in such a manner as to elicit interested and valuable discussions, and both as regards attendance and activity the meeting may be classed as one of the most successful which has yet been held. Apart from the professional papers, and the discussions upon them, we may note the interest which attaches to certain of the reports of the various committees.

Thus the status of the new Union Engineering Building was set forth as being in a satisfactory condition. The ground has been cleared, the various legal matters in connection with the formation of the holding corporation have been arranged, and the detailed plans for the structure are in an advanced state of preparation, so that the letting of the contracts is the next step in the prosecution of the work. The portion of the building to be occupied by the combined libraries of the several societies has been given especial attention by a joint committee, composed of members of the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, and this committee has held monthly meetings since the time of its appointment for the purpose of discussing the various details of the arrangement of what, it is hoped, will become the greatest engineering library in the United States.

As twenty-five years have elapsed since the foundation of the Society, a historical committee has been appointed, and has been actively engaged in collecting data and information relating to the early history of the organization. It is evident that this work has been commenced none too soon, since much interesting matter might otherwise have been lost. It is still desirable to add to the material which has already been gathered, and the committee is most desirous of procuring from any of the members who attended the preliminary meeting at the old office of the *American Machinist* on February 16, 1880, any notes or matters of interest relating to that historic event.

The later history of the Society is recorded very fully in the volumes of its Transactions, but few could foresee, at the date of the formation of the original gathering, the important results which were to flow from that meeting, and hence many things were overlooked in the early records which it is now most desirable to replace, and in this important work the aid of all the members should be enlisted.

* * *

AMONG the matters of current importance brought before the meeting should be noted the plea advanced by Col. E. D. Meier for the continuance of the work of the coal-testing plant, begun at the St. Louis Exposition, and now under consideration as an applicant for an appropriation of $100,000 by Congress. The immense importance of this study, and the fact that in no other way can an acceptable record of the heating value of American coals be secured, renders it extremely desirable that this appropriation be made. We desire here to record the emphatic endorsement of the Magazine to this work, under the full conviction that it will return to the nation many times the value of the moderate appropriation requested.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE COST OF PRODUCTION.

THE INFLUENCE OF THE REDUCTION OF COST OF ARTICLES OF CONSUMPTION UPON THE PROGRESS OF CIVILISATION.

Alexander Siemens—Institution of Electrical Engineers.

THERE is becoming evident in all departments of industrial work an increasing appreciation of the interdependence of the various factors which go to make up modern civilised activity. Formerly the capitalist, the business manager, and the engineer each had his own department of work, and meddled, if we may use the word, but little with the fields of the others. To-day we find that the engineer is extending the methods of mechanical and physical science to the departments of finance and administration, and the results are becoming daily apparent.

In his inaugural address before the Institution of Electrical Engineers, Mr. Alexander Siemens discusses this important subject, his views attracting much attention and favorable comment.

Considering the features of modern civilisation generally, it must be acknowledged that its true foundation lies in the lowering of the cost of production, that is, that the progress of civilisation is in proportion to the cheapening of the articles of consumption.

"Although this may sound purely materialistic, the process of lowering the cost of production, which implies the employment of all the knowledge we can acquire, and of all the training the best schools can give us, results in greater ease of acquiring the necessaries for keeping alive, and therefore it gives us more time to cultivate other aspects of our existence. This general principle has manifested itself as much in the electrical industry as elsewhere, and further progress appears to be dependent on further lowering of the cost of its products. When we come to inquire into the means for carrying out this principle we soon recognise that the solution of the problem depends upon a variety of circumstances which all influence the result, although they may be investigated and discussed separately.

"For internal working every industry depends upon three principal factors: (1) the capital which provides the works and the raw material; (2) the workman who converts the raw material into the finished product; (3) the management. It is quite idle to try to establish the relative importance of these three factors. for each one is indispensable, and likewise the prosperity of each one is inseparable from the prosperity of the others; so that no industrial establishment can flourish where these three factors do not co-operate heartily and harmoniously. As a first condition for further progress we should in fact, recognise the identity of interest between the capitalist, the workmen, and the management, as any measure which is intended to unduly favour any one of these three factors would inevitably increase the cost of the product beyond what it ought to be and thereby restrict its sale, thus damaging all three. When we examine in detail in what way each of the three factors can contribute to the lowering of the cost of production, we find ample confirmation of the intricacy of the problem."

The share of capital in the value of the finished product is proportionate to the cost of the depreciation and maintenance of the works and outfit. the cost of raw materials.

and to the interest on the investment, represented by profit. It is evident that the first item is greatly affected by the skill with which the establishment has been planned and equipped, a matter largely in the control of the engineer. The question of the cost of raw materials is dependent to a great extent upon fiscal questions in the country in which the undertaking is carried on, and it should be remembered that practically there is no such thing as an absolute raw material, the raw material of one industry being the finished product of another, but it must be realised that the cost of materials should be kept as low as possible, and that every increase in this item is a hindrance to the development of the industry.

So far as profits are concerned, their rate is naturally dependent upon the interest-earning power of money in other parallel lines of investment, but the actual amount to be charged to the industry on this account is directly dependent upon the capitalisation, so that it is important to avoid burdening an undertaking with more capital than is required for setting it up as a going concern and for providing a reasonable amount of working capital.

"When considering the influence of the second factor—the workman—on the value of the product, it becomes clear very soon that the amount of work turned out in a given time has a twofold influence on the result, as the time occupied in producing an article not only regulates the amount of the wages, but also the proportion of the dead charges to be debited to the article. It is, therefore, quite certain that in order to contribute his share to the lowering of the cost of production of an article the workman has to turn out a greater number of these articles in a given time, and the problem is how to attain this object without endangering the interest of any one of the three principal factors. This sounds almost as if slave labour would prove an economic plan in the carrying on of industries: it can, however, hardly be contended that the interest of the workman is considered under such conditions, and for this reason alone it should be condemned, even if there were no other objections to it.

"There are, however, legitimate ways in which the amount of wages to be charged against an article can be diminished. Most important among them is the substitution of machine work for hand labour, and where this is done, unskilled labour should be utilised for running the machines under the supervision of a few skilled artisans. Here, again, the interests of the workman appear to suffer, and whenever he is confronted with a new labour-saving machine he airs his old grievance that machines will deprive the workingman of his living, just in the same way as he opposed the use of all machinery a hundred years ago. The lesson taught by experience has evidently not made an impression; but nobody can deny that, instead of making skilled labour superfluous, the introduction of machinery has resulted in more skilled workmen being employed, and at better wages than before, and similar developments are likely to follow when the workman is further relieved from hard toil by his best friend, the labour-saving machine. Another feature of machine work is the greater accuracy that can be attained, so that, while the cost of production is lowered, the quality of the product is improved, and at the same time the interchangeability of parts is secured, which in itself contributes to the lowering of cost. It is not easy to convince workmen that 'increase of output' is of advantage to them; if we are to accept statements published in the newspapers, they rather believe in the direct opposite, 'restriction of output,' although their official organs repudiate the idea."

Taking up the question of management, and its influence on the cost of production, Mr. Siemens considers it as including: the selection of the site for a works, their planning and equipment; the commercial work connected with the business; the arrangements for carrying on operations; and the investigation of new methods of manufacture. Although the engineer is gradually entering upon the conduct of the first three of these departments, Mr. Siemens considers principally the last, showing the rules which should govern the designing of apparatus and the development, by experimental investigation, of new methods of work. In doing this he addresses particularly those who have recently been graduated from technical colleges, showing the desirability of their acquiring by experience the nature of the practical difficulties to be overcome.

"It is not so important that they learn to overcome these difficulties as easily and as quickly as a skilled workman, but that they acquire the habit of thinking how to avoid these difficulties when they are designing new work, and how to take advantage of the material at their disposal. In other words, a designer should have an intimate acquaintance with the scientific principles that come into play and with the ways in which they are applied, and he should know, if possible from personal experience, the capabilities and the limitations of the workman and of the machinery by which the operations are carried out. It is, however, by no means sufficient for preparing suitable designs to be well acquainted with the means employed to executive them; it is just as important to form an accurate conception of the problem that has to be solved, and to possess a thorough knowledge of previous attempts in the same direction, and of the causes of their success or failure.

"Another branch of knowledge required for the good management of factories is a careful training in the way of conducting experimental investigations, coupled with the good judgment as to which investigations are worth taking up. No doubt the list of qualities that ought to be found in a good manager could be extended still further, but enough has been said about all the three principal factors to show the great number of different points which have to be considered in connection with the internal working of modern industries. Besides these internal factors, there are all the external circumstances which influence the well being of the industries, and it is easy to see, even without entering at length into further details, that no true picture of the state of an industry can be arrived at if only a few features of their complicated constitution are to be taken into consideration."

Mr. Siemens concludes his address with a reference to the influence of standard systems of measurement, such as the metric system, upon the reduction of the cost of production, together with the effect of patent protection upon the development of industries, and the whole forms a very interesting and instructive paper.

SOME REFINEMENTS OF MECHANICAL SCIENCE.

ACCURATE METHODS OF MEASUREMENT AS APPLIED TO THE DIVISION OF TIME, ANGLES, AND LINES, IN PRACTICAL WORK.

Ambrose Swasey—American Society of Mechanical Engineers.

FOR a number of years it has become a custom in the American Society of Mechanical Engineers for the retiring President to select for the subject of his address some topic of engineering work with which he has been closely identified in practice. This excellent practice has resulted in producing, instead of the somewhat trite and stereotyped essay commonly suggested by the term "presidential address," a monograph upon an important department of engineering work, by an acknowledged specialist, and the *Transactions* of the Society have been correspondingly enriched.

At the recent convention of the Society Mr. Swasey chose as the subject of his address the matter of some refinements of mechanical science, and those who know of the remarkable work which has been done by Mr. Swasey and his associates in the adaptation of the precise methods of the laboratory to the workshop will realize the value which must attach to an address upon the subject from such a source.

Mr. Swasey takes up first the question of the division and measurement of time, discussing first the historical side, and following with some interesting notes about the accuracy of modern timekeepers.

"Galileo's beautiful discovery of the isochronism of the pendulum from the swinging chandelier in the church at Pisa, was of great value in many respects, but in none more so than in its application to the measurement of time.

"Soon after that great discovery the English clock-maker, Graham, invented the mercurial pendulum, by which the variation in its length caused by the difference in temperature was fully compensated, and some years later Harrison, another English clock-maker, invented a compensating pendulum, which consisted of a series of metal bars having different coefficients of expansion—so that two hundred years ago, as it is to-day, the pendulum was the nearest perfect of all the devices that have been employed for governing or controlling the motions of a clock mechanism.

"Every part of the clock down to the minutest detail has been the subject of study and improvement, and they are made and adjusted with such precision and delicacy that in testing them the question is, within how small a fraction of a second will they run. Not content with their marvelous performance when under normal conditions, some of the finest astronomical clocks are surrounded by glass or metal cases, in which a partial vacuum is maintained, and in order that the cases may not be opened or disturbed, the winding is done automatically by means of electricity; the frequency of the winding in some cases being as often as once every minute. These clocks are set up in especially constructed rooms or underground vaults, where they are free from jar or vibration, where the temperature and barometric conditions remain practically constant, and where every possible precaution is taken to further minimize the errors of the running rate.

"A clock in the observatory at Berlin has run for several months under these favorable conditions, with a rate having a mean error of but fifteen one-thousandths of a second per day and a maximum error of thirty one-thousandths of a second per day.

"Another clock installed at the observatory of Case School of Applied Science at Cleveland, running under similar conditions, also has a mean error of fifteen one-thousandths of a second per day, with a maximum error for several months of but twenty-two one-thousandths of a second per day.

"These are notable examples of the present state of the art of clock-making, and show the wonderful precision with which minute intervals of time can be measured."

Passing to the subject of the division of the circle, Mr. Swasey shows how the improvements in machinery and methods of graduation have made it possible to produce upon small circles graduations far more accurate than were possible upon the large circles used down to the close of the 18th century. At the present time the more modern astronomical instruments are provided with graduated circles of thirty inches in diameter and under, the reading being done with the aid of microscopes, and fractions of a second being easily read.

In connection with the question of measurements of length, the dividing engine of Professor Rowland is stated to be the most accurate, diffraction gratings having been ruled upon it as fine as 43,000 lines to the inch, with a maximum error of one-millionth of an inch.

"The production of these gratings, which has enabled the physicist in his study of the spectrum to enter fields of research before unknown, has not only called for the highest degree of perfection ever attained in the spacing of linear distances, but it has also called for a refinement most difficult in the optical surfaces upon which the lines are ruled. To Mr. Brashear was given the problem of producing such surfaces, and notwithstanding the many difficulties encountered in working and refining the speculum metal plates, he has made many hundred plates with surfaces either flat or curved with an error not to exceed one-tenth of a wave length of light, or one four hundred thousandth of an inch.

"The established standards of length which are the yard of Great Britain and the meter of France, being made of metal, and liable to destruction or damage, Prof. Michelson conceived the idea of determining the lengths of these standards in wave lengths of light, which would be a basis of value unalterable and indestructible.

"For the purpose of carrying out these experiments, the interferometer was constructed, an instrument which required the highest order of workmanship and the greatest skill of the optician. Again Mr. Brashear proved to be equal to the occasion, and made for the instrument a series of refracting plates, the surfaces of which were flat within one-twentieth of a wave length of light, with sides parallel within one second. This was the most difficult work ever attempted in the refinement of optical surfaces.

"Professors Michelson and Morley devised a method tor using the interferometer for making the wave length of some definite light an actual and practical standard of length. So satisfactory was the result that Prof. Michelson was invited to continue the experiments at the Bureau of Weights and Measures, at Sèvres, France, where the standard meter, which is kept in an underground vault and inspected only at long intervals, was used for that important work, which occupied nearly a year. The final result of the experiments shows that there are 1,553,164.5 wave lengths of red cadmium light in the French standard meter, at 15 degrees Centigrade. So great is the accuracy of these experiments, that they can be repeated within one part in two millions. Should the material standard of length be damaged or destroyed, the standard wave length of light will remain unaltered, as a basis from which an exact duplicate of the original standard can be made. These two marvelous instruments, the Rowland dividing engine and the Michelson interferometer, show the possibilities in the perfection of linear divisions and the standards of length."

The interesting feature about the development of the branch of engineering science included in Mr. Swasey's address lies in the fact that much of the marvellously accurate work which he describes has been done in the modern machine shop, and that it has been found that the application of machine-shop methods to such work has greatly facilitated the improvement in the methods as well as in the resulting product. Conversely, the execution of such work in the machine shop tends to raise the standard of accuracy in all departments of work to the benefit of machine practice at large.

METALLURGICAL SLAGS.

THE FORMATION OF SLAGS IN METALLURGICAL OPERATIONS, THEIR CONSTITUTION AND INDUSTRIAL APPLICATIONS.

W. Mathesius—Revue Générale des Sciences.

IN nearly every metallurgical operation in which metals are reduced by exposure to temperatures above the melting point scoria and slag are formed, and the part which these play in the operations is one worthy of careful study. In a recent issue of the *Revue Générale des Sciences* there appears a general study of metallurgical slags, by Professor Mathesius, presenting in a condensed manner the general process of the formation of slags in the processes of metallurgy, together with some account of the efforts which have been made to utilize these products of the furnace.

There are two conditions under which slags are formed in the furnace: first, when the products of the reaction accompanying the metal, or formed at its expense, are not gaseous; and, second, when the minerals used contain in themselves constituents which become fused in the course of the operations. As examples of the first class may be cited the slags appearing in the operations of puddling, the Bessemer process, the open-hearth process, and the basic processes. In this class also belong the slags formed in the preparation of metals by reducing substances of which the oxides or sulphides are not gaseous, such as iron, silicon, and aluminum. Examples of this are seen in the metallurgy of lead, resulting in the displacement of the lead from its sulphides by iron; or, again, in the aluminothermic processes of Goldschmidt, in which the various metals are replaced, usually from their oxides, by aluminum, with the formation of alumina as a slag. The slags of the second class include those produced by the direct fusion of the flux in the production of metals in the high furnace, as in the smelting of iron, copper, lead, etc.

Slags have important functions in metallurgical operations, acting both in the collection of the reduced metal and also aiding in the production of the desired chemical reactions. Thus, when a metal is produced in a high furnace, the reduction of the oxides and the fusion of the mass take place above the zone at which the air is delivered through the tuyeres. The fused metal descends in small masses to the hearth of the furnace, but in so doing the isolated drops must pass through a region characterized both by a very high temperature and an oxidizing atmosphere. Each drop becomes coated with a film of oxide, which, if not removed, would mingle with the metal on the hearth, to the deterioration of its quality. The drops of metal, however, do not fall directly into the bath on the hearth, but are received by the layer of fused slag, which, because of its lower specific gravity, floats above the liquid metal. Each drop of metal is thus cleansed of its film of oxide in passing through the layer of slag, the oxide thus removed being reduced anew by the carbon floating on the slag bath or partially dissolved in it.

Another function of the slag in a furnace is that of a regulator of temperature. It is the fusing point of the slag which determines the temperature maintained in a high furnace; thus the temperature of the melting of the slag determines whether lead is separated alone or in connection with iron; and, in like manner, the temperature in the blast furnace determines the production of gray or white iron.

The slag may serve as an intermediary in the reactions in the furnace, acting as a solvent for the reagents. An example of this is seen in the basic Bessemer process, in which the dephosphorization does not become active until a sufficient quantity of slag has been formed.

Slags may consist of sulphides, spinels (aluminates, ferrates, etc.), silicates, and phosphates. The manner in which these elements are combined is discussed at some length by Professor Mathesius, with especial attention to the series of silicates and of phosphates, from the point of view of the chemist, for which the reader must be referred to the original paper. As of especial interest to the engineer, the discussion of the methods of utilizing slags as by-products is of importance, especially in view of the necessity for disposing of the constantly accumulating mass of such material in the vicinity of all metallurgical works.

Slags formed of metallic oxides and sulphides, with the exception of those resulting from the processes of aluminothermy, are resubmitted to reducing operations, and need no further mention. The alumina produced in the process of aluminothermy is analogous to natural corundum, but exceeds it in purity and hardness, and finds a ready application as a polishing substance and as a material for the preparation of ceramic products possessing a great resistance to the action of acids united with a high thermal conductivity.

Numerous attempts have been made to utilize the silicate slags produced in such great quantity by the blast furnaces of various countries; the earlier attempts, as long ago as 1859, being to produce bricks or blocks of artificial stone for building purposes. By mixing pulverized blast-furnace slag with slaked lime, and exposing the moulded forms to the action of the air, it was found possible to make substantial blocks, but the cost of the grinding, and large proportion of lime required, rendered the operation unsuccesful commercially. It was not until the successful efforts of Lürmann, in 1870, to granulate the slag by delivering it into water as it flowed from the furnace, that the possibility of utilizing the material was made evident. Experience showed that the granulated slag possessed distinct hydraulic properties, similar to the natural puzzolana of Italy, and that by mixing it with about one-third part of slaked lime a cement was produced which could be made very useful for many purposes. Another use for the granulated slag appeared when it was found that it could be added, in a finely ground condition, to ordinary Portland cement, in quantities up to about 30 per cent. to the distinct improvement of the whole. Experience with these products showed that all slags were not suitable for the production of cement, and the trade disputes and contests which followed can readily be accounted for under such conditions. More recently the true method of making a high-grade cement from slag has been discovered, this being to mix the granulated slag with unburned limestone, and to vitrify the mixture in a kiln, the resulting clinker being ground to a fine powder, exactly as in the course of the regular manufacture of Portland cement. The product differs in no way from Portland cement, either in constitution or properties, and thus a standard material of construction is now being made in large quantities from what was formerly a useless and inconvenient by-product.

Professor Mathesius calls attention to a new method of producing a slag cement, developed by himself, and based upon the property of certain silicates of lime to swell and crumble in the presence of moisture. By taking certain basic slags and exposing them, after granulation, to the action of high-pressure steam, they are found to swell and become decomposed into an exceedingly fine amorphous powder, which needs only to be mixed with water to form an effective cement. This process furnishes a cement much finer than has yet been produced by grinding, and at a lower cost, and it should find numerous useful applications.

The phosphate slags, resulting from the basic process of making steel, have been extensively used for purposes of fertilization. As they contain from 16 to 20 per cent. of phosphoric acid, it was early attempted to prepare them as fertilizers by chemical treatment, but it was soon discovered that it was only necessary to expose the ground slag to the action of the atmosphere and weather for it to be converted into a satisfactory fertilizer.

The ground slag, when examined under the microscope, is seen to consist of isolated mineral particles, and it must be subjected to the process of disintegration before its phosphoric acid can be assimilated by plants. It is therefore useless, and even injurious, to use the basic slag upon growing plants, and the material should be placed upon the ground far enough in advance for the disintegration to be effected before the plants have arrived at such a stage of development as to be capable of absorbing the phosphoric acid.

Professor Mathesius has found that when the basic slag is subjected to the action of high-pressure steam it becomes disintegrated and pulverulent, much in the same manner as the siliceous slags, and that after this treatment the contained phosphoric acid is readily dissolved in the soil and assimilated by growing plants, so that this process may be found of value in connection with the use of slags as fertilizers as well as in the manufacture of cement without the necessity for grinding.

The whole development of this subject of slag utilization is an excellent example of the manner in which processes of manufacturing technology are overlapping, so that, instead of a process consisting of a main productive operation, accompanied by so-called by-products of doubtful value, we have, in many cases a series of parallel processes, each of much importance in itself, and all combining to utilize nearly every reaction involved.

STEAM TURBINES AND RECIPROCATING ENGINES.

THE BEST ECONOMY OF THE PISTON STEAM ENGINE AT THE ADVENT OF THE STEAM TURBINE.

J. E. Denton—International Congress of Arts and Sciences.

IN view of the general interest at present apparent in the steam turbine it is most desirable that the true relative position of the reciprocating engine and the turbine be critically established, and for this reason the paper presented by Professor J. E. Denton before the International Congress of Arts and Sciences at St. Louis is especially valuable at this time.

Professor Denton reviews the original dictum of Watt, that steam economy depended solely upon the expansion ratio, and showed how the defect in this, namely, the loss from cylinder condensation, did not appear in the Cornish pumping engine because the working end of the cylinder was never exposed to the temperature of the condenser. The experiments of Isherwood upon the engines of the Michigan, and their analysis by Rankine showed the real cause of the limitation, and led to the development of the compound and multiple-expansion engine, permitting an extension of the expansion ratio to be made to advantage. Taken together with the structural improvements in marine boilers, rendering higher steam pressures available, the development of the recprocating marine engine can be traced until, with boiler pressures of 210 pounds per square inch, and about 16 expansions in four cylinders, a water consumption of 13.6 pounds per horse-power-hour is recorded. This means, taking into acount the consumption of auxiliaries, etc., a fuel consumption of about 1.3 pounds of coal per hour for each indicated horse power.

"Without an increase in boiler pressure above 210 pounds further increase in economy can only be obtained with higher ratios of expansion and this is prohibited because the consequent reduction of mean effective pressure would increase the weight of the engine per horse-power beyond commercially acceptable limits.

"With higher boiler pressure greater economy can be obtained from the engine by increasing the expansion up to probably a ratio of 30, but to accomplish this without increase of weight of engine per horsepower would require a working pressure of steam of 300 lbs. per square inch. This must be obtained from water-tube boilers, as the Scotch boiler is now at the limit of practicable construction and allowable weight when built for 210 lbs. steam pressure.

"Higher economy of engine is obtainable, with present pressures and ratios of expansion, by the use of superheated steam, but the application of the latter has not thus far shown a gain in coal economy in trans-Atlantic marine practice. This is doubtless ascribable to the use of imperfectly-designed superheaters; but the increase of cylinder oil which superheating requires makes its successful introduction at sea questionable, on account of the difficulty of protecting the boilers against over-fouling by accumulation of oily deposit.

"At the advent of the steam turbine in marine practice, therefore, the degree of economy with which it must compete, in marine engines on the largest scale, is that of a quadruple-expansion system expanding saturated steam with 210 pounds pressure, fifteen times, into a vacuum of 25.5 inches with an economy of 13.6 pounds of water per horse-power-hour of the main engine; which will operate, with its auxiliaries, from Scotch boilers on the Howden system, with a consumption of 1.3 pounds of the best semi-bitumenous coal per indicated horse power of the main engine.

"If the turbine could operate screw propellers efficiently with the same rotational speeds for a given horse-power that it uses in electric service, the record for economy already established by the turbine shows its ability to easily compete with these conditions of performance of the best marine engine. But such rotational speeds for the turbine are inconsistent with the degree of screw propeller efficiency available from piston engines.

"Therefore the possibilities as regards steam economy of the turbine in marine practice are as yet too unsettled to permit of their definite statement within the limits of this paper.

Passing to the stationary engine, Professor Denton shows how, by the introduction of compound and triple-expansion engines, the water consumption of 19 pounds per horse-power-hour attained in the simple stationary engine has been lowered to about 12.5 pounds, and how this has been equalled by compound engines of large cylinder ratio, about 7 to 1, and also by compound engines of lower cylinder ratios.

"These facts show that the minimum water consumption of the compound mill engine, and electric light engine of the present day, using saturated steam, is not dependent upon any particular cylinder ratio and clearance nor upon any system of jacketing, but that the essential condition is the use of a ratio of expansion of about 30, above which the cylinder-condensation loss is liable to prevail over the influence of the law of expansion. The conclusion appears warranted, therefore, that if this ratio of expansion is secured with any of the current cylinder and clearance ratios, and with any existing system of jackets and reheaters, or without them, a water consumption of 12.4 pounds per horse power is possible, and that a variation of four-tenths of a pound below or above this figure may occur by the accidental favorable or unfavorable jacket and cylinder-wall expenses which are beyond the exact control of the designer."

Comparing these piston-engine performances with those of the steam turbine, Professor Denton shows that it is necessary in the latter machine to use the brake horse power, since no indicator diagrams are possible, and by making reasonable allowances for the frictional resistances of the piston engine he gives, for the water consumption per brake horse-power-hour, 14.51 pounds for the turbine as against 14.56 and 14.64 pounds for American and Continental engines respectively.

"While the mill and electric practice has developed the compound engine, pumping engines in the United States have been developed in the triple-expansion fly-wheel type to a degree of economy superior to that afforded by any compound mill or electric engine, and, for saturated steam, superior to that of the pumping engines of any other country. This is because their slow speed permits of greater benefit from jackets and reheaters and of less losses from withdrawing and back pressure. These causes, together with the greater subdivision of the range of cylinder, have resulted in records made between 1894 and 1900 of 11.22, 11.26 and 11.05 pounds of saturated steam per indicated horse-power, with 175 pounds steam pressure and from 25 to 33 expansions, in the cases of the Leavitt, Snow and Allis pumping engines, respectively, the corresponding heat consumptions being by different dispositions of the jacket drainage, 204, 208 and 212 thermal units per indicated horse-power-minute; while the Allis pump, with 85 pounds steam pressure, has lowered the record to 10.33 pounds of saturated steam per indicated horse-power, with 196 heat units of consumption per horse-power-minute.

"The turbine can compete with these pumping engines only through the medium of a multiple-stage centrifugal pump, whose efficiency taken even at 80% will probably impose too great a loss of motive power on the turbine system for successful competition with this high class of piston pump, since the friction loss of the latter is only 5% of the indicated horse-power."

With regard to the questions of superheating and of the utilization of the waste heat in engines of the binary vapor form, such as the sulphur dioxide engine of Josse, Professor Denton shows that similar methods are applicable to the turbine as well as to the piston engine, and hence may be considered as eliminated from the comparison.

"The turbine, therefore, even at this early period of its history, is already a formidable competitor to the piston steam engine in its most economical degree; and that it is so is mainly due to the fact that with no more waste in its steam action from internal friction than is due to the cylinder-wall wastes of the piston steam engine which are absent in the turbine, it more completely realizes the expansive principle enunciated in the infancy of steam history as the fundamental factor of economy, by its sagacious founder, the immortal James Watt."

WATER-TUBE BOILER DESIGN.

A COMPARISON OF THE EFFECTIVENESS OF WATER-TUBE BOILERS FOR VARIOUS POSITIONS OF TUBES.

W. R. Cummins—North-East Coast Institution of Shipbuilders.

WATER-TUBE BOILERS may be broadly divided into two classes, according to the general position of the tubes. In one class the tubes run in a vertical, or nearly vertical position, while in the other the position is nearly horizontal. The respective merits of these two arrangements are discussed at length in a paper presented before the North-East Coast Institution of Shipbuilders by Mr. W. R. Cummins, and the general subject of the design of water-tube boilers is treated at length in the same connection.

Mr. Cummins naturally considers the boiler with especial reference to marine service, but the general points apply to stationary purposes as well. The conditions necessary for commercial success in a boiler are enumerated as those affecting the fuel economy, the weight and space economy, the cost or capital economy, and the economy of operation or maintenance. The relative importance of these various conditions depends somewhat upon the service, the matter of weight, for instance, being an important question for a marine boiler, and of secondary consideration for land service.

The conditions necessary for high fuel economy are stated to be perfect combustion and perfect efficiency of heating surface.

"Perfect combustion is an unmixed blessing and does not interfere with any of the other economical conditions. On the other hand, to secure perfect efficiency of the heating surface would mean an almost unlimited amount of it, which would seriously interfere with weight and cost economy.

"One of the chief sources of loss in burning fuel in a boiler is due to the excess air which has to be admitted to provide for complete combustion to CO_2 and H_2O. The whole of this excess air has to be heated up to the temperature of the rest of the gases and thus carries off a great deal of heat to the funnel. This source of loss is common to all boilers and may be largely reduced by skilled firing and proper proportioning of firebar spaces and air admission. It is very probable that with oil-fuel the excess of air over that actually required for perfect combustion is not so much as with coal-fuel; hence the furnace efficiency should be greater."

In considering steam boiler economy it must always be remembered that the furnace is distinctly a piece of chemical apparatus, and that its function is the production of heat by the combustion of fuel. while the boiler proper is a piece of physical apparatus, designed to absorb the heat produced in the furnace and convert it into mechanical energy in the steam.

Considering the furnace in itselt, it is generally admitted that the form and size of the combustion chamber is an important element. By the combustion chamber is meant the space immediately succeeding the grate, along the direction of the movement of the products before the actual heating surface of the boiler is reached. In order that the combustion should take place effectively it is necessary that the gases should be caused to mingle thoroughly with the air, and that sufficient time should be given for the chemical changes demanding a high temperature to be completed before the cooling surfaces of the boiler are reached. The rate of transfer of the heat from the gases to the water depends upon their difference in temperature, so that the efficiency of both the furnace and the boiler depend to a large degree upon the production and maintenance of a high temperature in the combustion chamber. In any case the time occupied by the passage of the gases through the boiler is never more than a few seconds, so that every facility for the completion of the combustion and the transfer of the heat must be given if even a fair degree of efficiency is to be secured.

Mr. Cummins points out that the various designs of boilers with vertical water-tubes give an excellent opportunity for the provision of a large combustion space having its greatest dimension in the line of the flow of the gases, while those forms in which the tubes are horizontal, or nearly so, have the lower rows of tubes just over the grate bars, where the green gases coming off the fuel must be cooled down below combination temperature. In some forms of boilers the combustion takes place in a sort of Dutch oven, placed in front of the boiler proper, this being a recognition of the desirability of providing for better facilities for combustion before the heating and cooling surfaces of the boiler are reached.

Coming to the elements in design which affect the efficiency of the boiler itself, Mr. Cummins shows that the maximum possible economy in the transfer of the heat depends upon heating-surface efficiency. Theoretically the greatest efficiency would be obtained when the temperature of the escaping gases in the chimney was just equal to the temperature of the water in the boiler, but such a condition is commercially impracticable. In actual practice the attention which can be given to heating-surface efficiency is limited by other requirements, and like all other engineering structures, a steam boiler is a compromise. When economy in weight is the controlling question the heating surfaces are necessarily restricted and the chimney temperatures are consequently high. In like manner economy in cost involves limitations to heating surface and corresponding diminution in efficiency. In every case, however, it is desirable to put the heating surface into the most efficient condition, and the elements by which the designer is able to influence the quality of heating surface are enumerated as: thickness of transmitting surfaces; circulation of the water; and circulation of the gases.

The thickness of the surface is not a matter of very great influence upon the transmission of heat, within the limits of thickness ordinarily used in steam boilers, the condition of the surfaces being more important, and freedom from soot on one side and scale on the other are of greater moment, so that facility for keeping both surfaces clean enter into the design.

So far as circulation of the water is concerned, the vertical tubes undoubtedly have the advantage, and none of the devices used in horizontal tubes, such as inner tubes or diaphragms, circulating nozzles, etc., need be employed when the tubes are placed nearly in the vertical position. Boilers using vertical tubes are also free, in most cases, from the use of narrow and tortuous headers, so that a freer entrance and discharge may be provided.

Considering the circulation of the gases, it has already been noted that the entire duration of contact is very short, but it should be prolonged as much as possible, since the time element is an influential one. By the introduction of suitable baffle plates the gases may be prevented from passing directly to the chimney, and directed against portions of the heating surface which would otherwise receive less heat. In this respect there is not much difference between vertical and horizontal tubes, examples of both kinds being cited in which the baffles are well arranged to prolong the duration of contact. An important matter in connection with baffle systems is their maintenance, since the presence of leaks will materially diminish their effectiveness, and in this respect the vertical tubes have an advantage.

Mr. Cummins considers that it is best to have the path of the gases as nearly at right angles to the tubes as possible, and this idea seems to be generally prevalent. It has been pointed out, however, that the direction of contact of the gases with the tubes is not a matter of great importance, since the real cause of the transfer of the heat is the difference of temperature and not the "impinging" of the gases against the metal. It is well known that vertical fire-tube boilers are fully as efficient as the horizontal variety, and the same should be true in water-tube boilers regardless of the direction of the transfer of the heat.

Summing up, Mr. Cummins says, that so far as fuel economy is concerned, a large and high combustion chamber is an absolute necessity; and that vertical tubes, as small in diameter as practicable, are preferable in all respects to horizontal ones. It is equally important that the gases, on leaving the combustion chamber to enter among the tubes, are not rushed through too quickly, but are allowed sufficient time to give up their heat. It is also desirable that the gases be split up and divided into as many narrow streams as possible.

Mr. Cummins considers at length the conditions involved in the use of water-tube boilers on shipboard, especially in connection with economy in weight, and he shows the advantages of the vertical tubes in this respect also, his views in this direction agreeing closely with those of the Admiralty boiler committee.

VIBRATORY SPEED INDICATORS

THE ACCURATE DETERMINATION OF HIGH ROTATIVE SPEEDS BY THE UTILIZATION OF THE PRINCIPLE OF RESONANCE.

Friedrich Lux—Verein Deutscher Ingenieure.

HIGH rotative speeds have always been difficult of direct measurement, except by the use of expensive and complicated apparatus, and for a long time there has been a demand for a simple and reliable speed indicator. The various forms of revolution counters acting by pressure contact at the end of a revolving shaft or spindle become unreliable as well as inconvenient at high speeds, besides involving the noting of the time as well as the reading of the index. With the increasing use of machinery operating at high speeds, such as dynamos, motors, steam turbines, centrifugal pumps, etc., it has become more and more desirable that a good speed indicator should be available.

In order to meet this demand, and as a direct outcome of his own researches upon the vibration of screw-propeller shafts, Herr Hermann Frahm, a well-known marine engineer of Hamburg, has devised an apparatus which utilizes the principle of resonance to indicate the speeds of machines with which it may be connected, and from an article by Friedrich Lux, in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure,* we make the following abstract, describing its construction and operation.

The phenomenon of resonance is the property possessed by elastic bodies of responding to rhythmical impulses corresponding to their own period of vibration. A familiar example is found in the manner in which the strings of a violin or other stringed instrument can be felt to vibrate when their corresponding notes are sounded from some other source, and nearly every one is familiar with the experiment of making a glass lamp-shade ring by the singing of the note which it emits when struck. In fact it is upon this principle that the ear is supposed to possess the capacity of perceiving various tones, certain fibres responding to external vibrations corresponding to their own periods.

Herr Frahm has utilized this principle by the production of a very simple apparatus, this consisting merely of a set of vibrating reeds or tongues, made from pieces of watch spring, and tuned to different rates of vibration by being made of various lengths, and loaded with different weights. Each reed consists of a piece of watch spring, a set of such reeds being clamped between a pair of jaws so as to form a sort of comb, not unlike the steel tongues used in an ordinary musical box. The bar to which the reeds are fastened is also supported by a sort of spring suspension at one or both ends, the reeds standing vertically in a row. Each reed has its upper end bent sharply at right angles, and in the angle thus formed a drop of solder is placed, the size and weight of this piece of metal, together with the length and density of the reed, determining its time of vibration. It is thus possible to prepare a set of reeds having successive rates of vibration between any given numbers, and by covering the ends of the reeds with white enamel their movements are made clearly visible.

If such an apparatus is placed upon the base or frame of any machine in operation the vibrations, although imperceptible in themselves, will immediately affect the reed having the same rate or frequency, and as this reed can be readily seen, its number gives the speed of the vibrations. In many instances this is sufficient, but when the speed is to be read at a distance, or it is important to investigate any particular portion of a machine, the vibrations may be directly communicated to the comb. Thus a slight projection upon a rapidly rotating shaft may be used to cause a lever to make an oscillation for every revolution, and this, when communicated to the comb, will cause a response to be made especially by the reed having the same frequency. In this way revolutions far exceeding in number any possibility of ordinary counting or recording may be indicated very closely, this method having been successfully applied to steam turbines, Pelton water wheels, centrifugal cream separators, etc.

Another very useful method of setting the apparatus into vibration is to employ an electric current, a soft iron armature being attached to the bridge or base of the comb, and an electro-magnet, through the coils of which a current passes, set into vibration by a soft-iron toothed wheel, furnishing the impulses. In the case of alternating current machinery it is only necessary to cause the alternating current to pass through the coils of the electro-magnet and the number of vibrations thus caused will immediately be selected by the reed having the same period, and its increased vibrations will enable it to be perceived without difficulty. The advantage of the electrical method especially is that it renders it possible to place the indicator at any distance from the machine under observation, speeds having been successfully indicated by this method at points as far as 10 kilometres distant from the source.

One of the most important functions of such a device is its capacity for separating or analyzing a number of combined vibrations. If a number of rates or frequencies exist in the impelling source the reeds corresponding to the several simple frequencies will all be set in motion, and any great difference in their amplitude may serve to enable the predominating speeds to be selected for examination or study.

It is evident that such a device as is above described will find continually increasing applications, especially in view of the continual effort now apparent to do away as far as possible with reciprocating and alternating motions and use rotating parts wherever possible. Although every effort is made to avoid vibration in such machines as turbines, centrifugal pumps, blowers, etc., it is rarely found that entire freedom from periodic effects exist, and hence speeds can nearly always be determined by the use of analyzing reeds in the form devised by Herr Frahm. Of course it is not necessary to provide a great number of reeds upon a single comb, as the range of speeds under consideration is always fairly well known in any given case, and combs containing but a few reeds may be arranged for special purposes. The entire apparatus is but another example of the manner in which the methods formerly confined to the physical laboratory are being employed in daily and practical shop service, to the improvement both of the quality and quantity of workshop information.

MODERN WAR-SHIP DESIGN.

A PLEA FOR THE ADOPTION OF SIMPLER METHODS OF DESIGN AND CONSTRUCTION OF SHIPS OF WAR.

G. W. Dickie—Society of Naval Architects and Marine Engineers.

AMONG the important papers presented at the recent meeting of the Society of Naval Architects and Marine Engineers we note one by Mr. George W. Dickie, supplementing a paper which he contributed five years ago, and treating of possible improvements in war-ship design. At the time of the presentation of the previous paper, in 1899, Mr. Dickie gave two fundamental reasons for the complicated conditions existing on war vessels, and these, he affirms, exist to-day to a still greater degree. These are:

First: Uncontrolled growth of new devices for doing the many things for which mechanism is required on these vessels, without the new devices being considered reliable enough to supersede the old. Hence duplication, and, in many cases, triplication of apparatus for doing one thing for which one good device alone should be used.

Second: The system of divided control over the work renders it impossible to have a homogeneous design to begin with that would enable the ship and all that is required of her to be treated as one machine, and provision made at the start for every function being considered with relation to every other function.

"Since 1899 additional causes of complication have been brought into play. Special experts in certain lines of work have been given charge of the work in which they are expert, thus bringing about a struggle for room to place all the devices the experts think to be necessary to make their specialties complete. To make this possible, specifications have been prepared and cleverly worded to cover the unknown requirements of the future, which, when finally worked out, produced two results—a tangled mass of complications on the ship and a financial complication to the contractor. This further increase of complication has developed so rapidly during the past three years that shipbuilders have suffered very great losses in consequence. Ships now building, or in the last stages of completion, and which were supposed to be duplicates of those already built, the specifications and original plans having been identical, have been made much more expensive, more complicated, and, I fear, less efficient, by this process, most of which has been brought about at the shipbuilder's expense, through elastic specifications and non-elastic Boards on Changes."

In general Mr. Dickie presents in his paper an affirmation, and to some extent an elaboration of the idea suggested in his paper of five years ago, namely, the provision of a central passage, or sort of subway, so to speak, running throughout the entire length of the vessel, and containing in accessible arrangement all the appliances for managing and controlling the vessel. This idea has been expanded and developed, and in the present paper it is considered in connection with the design of an armored cruiser, although it is manifestly adapted for any other type of ship.

This passage, according to Mr. Dickie's plans, would be arranged as one water-tight compartment, without any subdivision between the bulkhead and the forward end. about 50 feet from the ram, and the automatic door just forward of the steering-gear compartment. Such a compartment, arranged according to Mr. Dickie's plans appears to be placed so that no damage, short of the total destruction of the vessel, could impair its integrity.

The first, and one of the most important uses of the central passage is for the simplification of the drainage system of the vessel. Beneath the central passage, in a space formed between two vertical keel plates, there would be a central gutter or main drain, and into this, through openings provided with valves, each compartment would be drained.

"The main drainage well is in itself a water-tight compartment, all openings into it being controlled from the central passage. Its size is 24 inches by 30 inches, being large enough to admit a man for inspection and painting. We have thus provided, as far as horizontal drainage is concerned, a complete system without adding anything to the general structure of the vessel, and it is a real drainage system into which every compartment above the inner bottom naturally drains, requiring only some simple means of lifting water that drains into the space between the vertical keels, and discharging it overboard.

"I would propose to abolish the whole present system of horizontal piping, and all manifolds and emergency connections to circulating pumps, with all their numerous connections and valves. I would have no such unnatural combination as a bilge and fire pump or a feed and bilge pump—the two functions are entirely opposed to each other. A good bilge or drainage pump is of no use as a fire or feed pump, and a good fire or feed pump is the worst possible form of pump for drainage purposes, for the reason that a drainage pump should be able to take either wind or water or any combination of the two, and that is what the type of steam pump called a fire and bilge pump will not do."

Passing to the question of ventilation, Mr. Dickie proposes to run an air trunk to connect with the central passage, the air being drawn in by electric fans, and delivered directly to the passage, which thus becomes the main air duct for the whole ventilation of the ship.

"All compartments requiring artificial ventilation, except the boiler compartments, will receive the air necessary for that purpose from the central passage. From the roof or sides of the passage, air ducts will extend to the determined point of delivery. This includes the main engine rooms and the dynamo rooms. All openings into the ducts will be closed by water-tight gates operated in the passage. These gates or valves will be opened or closed by the man in charge of ventilation in the passage, on order from the compartment or room to be ventilated. In living spaces the air would be delivered not far from the floor or deck of the compartment being ventilated, through a special type of louvre, arranged to stand close to the bulkhead and with slats to direct the air to any part of the room or compartment, as required. For all living spaces, the outlets from the central passage would be small, so that each room or compartment would have its own independent connection with the air supply. This is necessary in connection with another part of this arrangement, whereby the steam heater arrangement or radiator system is combined with the ventilation. At each outlet taking air to living quarters and berthing spaces a special radiator is fitted. This is combined with the shut-off valve, being a double coil, circular in form, made without joint, and so arranged that the ai on its way through the outlet must pass over the surface of the pipe forming the coil and thus becomes heated. This forcing the cold air over the steam-heated surface of the radiator would be very effective and enable the surface, in proportion to the space to be heated, to be very much reduced from that of the ordinary radiator. The amount of steam applied to the radiator would be regulated by the man in the central passage in charge of the heating system, as ordered from the rooms or spaces requiring hot air. Each room or space can thus be kept at the temperature required by the occupants, the steam pipes to and the drain pipes from the heaters would all be installed in the central passage and in charge of the man assigned to the duty of taking care of the heating arrangements. This removes a lot of steam pipes and fittings from the living spaces in the ship, where they are a continual source of trouble, and usually, to a large extent, very difficult to get at for repairs, and placing them where they will be always in sight, and in unobstructed lines where repairs and renewals can be made with the least trouble and expense."

The central passage naturally aids greatly in simplifying interior communication through the ship. By using telephones for all transmission of orders, and by placing a central telephone station in the passage the whole question of the transmission of instructions would be carried on as it now is in any well-regulated building ashore.

The entire system of fire mains would naturally be installed in the central passage, where immediate access could be had to any connection, the fire pumps being placed in a pump room, situated between the main engine rooms and the after fire rooms. In like manner all the piping involved in the pumping of the ship, including the connections for the bath rooms, water closets, etc., find a place in the central passage.

"Circulating water for the distillers would be taken from the flushing main and discharged overboard or returned to the main at a less pressure, if desired. Magazines above the water-line would also be flooded from the flushing main. Magazines below the water-line would be flooded by special arrangements as they are now. By this arrangement all plumbing and sanitary work would be arranged just as it is for a city water-works system, except that the water would be salt instead of fresh. In the branches leading up to such bathrooms as should have hot water, arrangements would be provided in the central passage for heating the water as required from the heater system, a coil being used for that purpose so as to avoid any loss of fresh water from the boilers. The party ordering the water from the central passage would give the temperature required. Hot water would be arranged for officers' baths and sick bay only. The engine room water service would also be taken from the flushing main by a branch direct from the pump discharge before it enters the central passage."

The general use of electric power on shipboard renders the central-passage plan especially well adapted tor the running of the necessary wiring. By having two independent dynamo rooms, situated on each side of the central passage, the switchboards may be arranged directly against the walls of the passage, and the wires run directly into conduits running along the sides of the passage, all branches being carried through water-tight stuffing boxes.

Mr. Dickie also treats in his paper of improved methods of coaling and of handling boats, and brings to all the details of warship design the fruits of his ripe experience, untrammelled by any of the hampering prejudices so apt to exist in the limitations of the official mind. and the result is a refreshing example of common sense applied to the use of materials, which, as Nasmyth has said, constitutes the highest qualification of the engineer.

IMPACT TESTS ON STEEL.

SUGGESTIONS FOR MORE RATIONAL METHODS OF TESTING STEELS IN CONNECTION WITH RESISTANCE TO SHOCK.

A. E. Seaton and A. Jude—Institution of Mechanical Engineers.

MATERIALS of construction may be tested in various ways, and the choice of the method of testing should depend largely upon the use which is to be made of the information thus acquired. In the methods usually employed the object is to determine the general properties of the material, and this being the case, there is no reason to vary the standard methods of testing by tension upon machines of approved type.

More recently there has arisen a feeling that materials of construction, and especially the standard commercial varieties of steel, should be tested under conditions approximating more closely those in connection with which failure may be expected. When a machine or other structure is carefully proportioned with respect to the working stresses and the normal resistances of the materials there is little danger of a breakdown in the ordinary course of operation. It is when some violent and unexpected shock occurs that the material gives way, and such conditions are far more difficult to meet than those met in the ordinary course of operations.

In a paper recently presented before the Institution of Mechanical Engineers by Messrs. A. E. Seaton and A. Jude, this question is taken up in a very practical manner, the paper attracting much interest among engineers and manufacturers generally. As the authors themselves state:

"The objects of the paper are to show some of the characteristics and peculiarities of the wrought steel as supplied by steel manufacturers for commercial purposes; to assist in the development of a more rational method of testing the suitability of such steels for each particular purpose of the engineer; and to point out a few of the peculiarities that are observed in the fracture of test specimens and actual pieces of machinery. It is in fact the outcome of the constant endeavour of engineers to avoid the use of material which might be dangerous in the construction of machinery liable to severe alternating stresses, and more especially to attempt to find the very best steel for those parts liable to shock, owing to the inability to make those parts larger in the very fast moving engines so much in demand to-day."

The various methods of testing steel are enumerated as including tension, compression, cross-bending, hammering out to a point or edge, fatigue by gradual reversal of stress, either in one plane or over the entire section, impact on notched and unnotched bars, chemical analysis, and micro-analysis.

The choice of the method of testing should depend to some degree upon the use to be made of the material under consideration. For structural work subjected to steady loads only, or to recurrent loads of only one kind, the tension test is a good and sufficient one. When, however, the structures are to be subjected to rapidly repeated loads of one kind, all more or less suddenly applied, as with bolts, studs, rails, etc., or to alternating loads, as in the fixed and moving parts of machinery, or as in many parts of a ship, something more is needed. The manner in which members subjected to such actions give way is sufficient evidence that the ordinary tension test does not give information which can be depended upon by the designer in determining dimensions and proportions.

An examination of the conditions of operation of a high-speed reciprocating engine, for example, shows that more than 87 per cent. of the whole machine is subjected to more or less shock, while pure tension forms an insignficant percentage of the whole stress. Similar conditions exist in the case of printing and textile machinery, and in nearly every kind of machine tool. Experiments upon the failure of bolts and studs show that fractures take place after a number of vibrations representing a short life in the case of high speed machines.

Under such conditions it appears that it is only by the careful use of the shock test that useful information can be obtained about materials which are to be used in this manner, and it is the impact test which the authors recommend for practical use. In making such tests the use of the notched bar is recommended for the test specimen, the practice of the Continental experimenters being followed to this extent. The advantages of the notched bar are, that it gives a gauge of the preponderant stress, and that it gives assurance of good ductility. This latter point is important because it has been shown that there may be obtained excellent results from tension and elongation tests with steels which are quite incapable of resisting shocks, while the impact test settles the question of resistance to shock and of ductility at the same time. Another important reason for using the notched test bar is because it represents more nearly than any other the existing state of affairs in actual work. Probably 99 per cent. of all forgings are notched in some way or other, not necessarily with a V nick, while sharp edges, internal and external, cannot always be avoided in machine design, or even deep scratches in actual construction.

"Opinions differ as to the best means of making the impact test, but on the whole the consensus of opinion appears to be that it should be made with a machine that breaks at one blow, and at the same time measures the energy expended in breaking the specimen. Mr. Frémont thinks that breaking by a series of blows gives results that are similar to those from a static bending test, that is, they are more a gauge of ductility and tensile strength than to resistance to shock. The authors are not with him in this opinion, provided that the blows are not heavy enough to produce material bending; it is possible that he means in this sense, much in the same way as Heyn adopted in a series of experiments on the 'overheating of mild steel.' Here he had a nicked bar with one end stuck in a vice. A blow was given by a hammer, bending it over to a right angle. A reversed blow knocked it back again, and so on until fracture occurred. This is not the method the authors have adopted, for with the weight and size of specimen used the bending is very small indeed even for the softest steels.

"From the very many bars that have been tested by them they have found the number of blows to produce fracture is a fair gauge of the toughness or anti-brittleness. But there is no relation whatever between this result and the tensile results except what has previously been mentioned, namely, that if the impact result is good the elongation is sure to be good too, but, on the other hand, a steel showing high tensile strength and good elongation may be useless to resist shock."

The second portion of the paper of Messrs. Seaton and Jude discusses the nature and peculiarities of the fracture of mild steel by shock, using the methods of metallography for illustration. It is impracticable to review this at length without reference to the numerous excellent micro-photographs, and the original paper must be consulted, but the thoroughness with which the nature and constitution of the fractures have been studied must be commended.

An appendix to the paper gives an abstract of the results of tests.

ELECTRIC LOCOMOTIVE TRACTION.

PUBLIC TESTS OF THE NEW ELECTRIC LOCOMOTIVE FOR SERVICE ON THE NEW YORK CENTRAL RAILROAD.

Electrical World and Engineer.

A FEW weeks ago there was made on the tracks of the New York Central & Hudson River Railroad some very interesting public trials of an electric locomotive, of the type now under construction for the service of the trains running out of New York City. Although the locomotives of which the machine tested was an example, are not intended to replace steam traction entirely, and will be used simply to provide an acceptable means of drawing the trains through the tunnel and beyond the suburbs by insuring freedom from the nuisance and dangers of smoke and steam, they will undoubtedly prove a powerful argument in the task of showing that electricity has capabilities hitherto undemonstrated.

A brief statement of the facts in connection with the service of these machines will show the importance of the matter.

"The New York Central & Hudson River Railroad Company is now electrically equipping its terminal network for a distance of 34 miles on the main line from the Grand Central Station to Croton, near Peekskill, and for 24 miles on the Harlem Division as far as White Plains. It is the intention to handle all the traffic within this district or zone electrically, and the locomotive just given trial is one of thirty to fifty which will be used in the haulage of the through passenger trains, the heaviest of which reach 875 tons in weight and are to be hauled at a maximum speed of 60 to 65 mechanical horse power. By the use of the Sprague General-Electric multiple-unit system of control, two or more locomotives can and will be coupled together and operated from the leading cab as a single unit. The motive power may, therefore, be easily adapted to weight of train with no complication in operation and with uniform make-up of train crew. A single electric locomotive will be able to maintain the schedule with a 450-ton train, two locomotives being coupled together for heavier trains.

"This change of motive power is confidently expected to show marked economy in the electrified part of the railroad as a whole and a sharp increase in the suburban traffic, on account of the frequency of service, the greater acceleration, the purification of the Park Avenue tunnel, as required by law, and the general increase in the comfort, convenience and cleanliness of the methods adopted. As already noted, one step in the change of motive power has been the location of two large central turbo-generator power plants, one on each flank of the district served, namely, at Yonkers on the Hudson and Port Morris on Long Island Sound. Each of these plants, already designed and in embryo construction, is to have an ultimate capacity of 30,000 kw., with an auxiliary system of substations and storage batteries and an interconnection that will enable either plant to do the whole duty and carry the entire load of a train service far beyond that which depends upon the present steam schedule."

A general description of the locomotive is given in the article above referred to, and but a brief account will be necessary here. One of the most important features noted is the fact that the electric motors, of which there are four, are directly attached to as many axles, there being no gearing. Each motor is of 550 horse power, thus giving 2,200 horse power for the machine, and in the course of the trials there has been developed 2,780 horse power at the motors. This output is secured without in any way exceeding the safe commutation limit of the motors, and with a coefficient of traction of only 22.5 per cent. of the weight upon the drivers, thus placing this electric locomotive in advance of any steam locomotive yet built.

"Throughout both the starting and running tests the electric locomotive shows its remarkable smoothness and steadiness in running, a distinct contrast in this respect to the steam locomotive, especially should the latter be forced to perform the work here shown to be accomplished by the electric locomotive. The elimination of gear and bearing losses permits of a very high efficiency of the locomotive. Reference to the motor characteristics shows a maximum efficiency of approximately 93 per cent., this value being fully 4 per cent. better than possible with motors of the geared type. This gain is especially noticeable at the high speeds, the efficiency curve remaining above 90 per cent. even at the free running speed of the locomotive alone, in contrast to the 85 per cent. or less which would be a good showing for a locomotive provided with geared motors. The simple construction and high efficiency made possible with this design of gearless motor, together with the minimum cost of repairs attending such a construction, makes the direct-current, gearless motor type a distinct forward step in electric locomotive construction.

"Compared with existing steam practice, it is interesting to note that the heaviest 'Atlantic' type locomotive of the New York Central Company weighs approximately 150 tons, including the tender, on which but 47 tons are on two pairs of drivers. It will, therefore, be seen that for every pound of effective drawbar pull the steam locomotive has a weight of over 12 pounds, as compared with but 6 pounds with the electric locomotive. Therefore, in a single electric unit, over 25 per cent. greater weight is available for traction than with the largest steam passenger locomotive now in use, with 37 per cent. less dead weight and with 28 per cent. less weight on each axle. Moreover, the electric locomotive will, of course, have an entire absence of counterbalancing of driving wheels and twist from reciprocal motion, both of which in the steam locomotives are so destructive to track and roadbed."

The various runs which were made before a critical party of engineers and scientific men showed the capacity of the machine to be fully equal to any of the demands which may be made upon it. An eight-car train, weighing 431 tons, was hauled at a speed of 63 miles per hour, while a four-car train, of 265 tons weight, reached a speed of 72 miles per hour.

"A question that arises in connection with the application of electricity to the heavy service of the New York Central is that of heating. It is expected that in the majority of instances sufficient heat will be retained in the trains delivered to the electric locomotive at the end of the steam run to carry the cars to the terminal without any additional heat from the locomotive. To meet an emergency or contingency of this kind, however, it is probable that a flash boiler of the automobile type will be used on the electric locomotive, occupying but a small space in the operator's central cab, where at present a good deal of room is available. It will be understood that for the ordinary suburban service of the company within the electrical area, the usual electric heating equipment now familiar on street cars will be installed. But, of course, at this early stage, all kinds of passenger cars will be coming in as usual over the New York Central from foreign systems where electric traction has not yet been adopted, and for these at least some such provision as that noted above is in contemplation.'

With such experiences as have been recorded in the trials by the New York Central Railroad, together with the success of the Orleans Railway in Paris, and the plans of the Pennsylvania Railroad for New York, it is evident that the era of the use of heavy steam locomotives for the hauling of trains into terminals in the densely populated portions of great cities is passing, and that before very long the general practice will relegate the steam locomotive to the hauling of the trains through the open country, leaving the terminal work to be done entirely by means of electric traction.

CHEMISTRY IN THE FOUNDRY.

PRACTICAL APPLICATIONS OF METALLURGICAL CHEMISTRY IN THE SUCCESSFUL CONDUCT OF FOUNDRY OPERATIONS.

Dr. Richard Moldenke—New England Foundrymen's Association.

IT has long since been demonstrated that the services of a competent chemist and laboratory are necessary for the profitable conduct of the business of manufacturing iron from the ore, but the practical value of the chemist to the iron foundry is a matter of more recent demonstration. In a recent address delivered before the New England Foundrymen's Association, Dr. Richard Moldenke gives some excellent reasons why the services of a chemist should be considered, and how they may be made of commercial and practical value.

Dr. Moldenke makes a warning against the mistake of assuming that the first thing to be done is the establishment of a laboratory, to analyze and dissect everything that is used or made. Such a procedure involves unnecessary expense, antagonizes faithful workmen, and often fails of its purpose. A full working laboratory may be found advisable and profitable in connection with a large establishment, after its proper use has been found out, but the better plan at first is to proceed slowly, and use the cheapest means to the end until the progress made warrants the addition of a complete laboratory department.

The chemistry of iron can be made to pay almost immediately in the matter of the purchase of pig iron, and to-day more than three-fourths of the iron used is bought on chemical specification.

"Here the foundrymen, once he knows what he needs for his work, can specify the analysis required, and is certain of getting a more uniform material than ever he could when iron was judged by its fracture. The variation allowed the furnace before the shipment becomes subject to penalties, or even rejection, is such that a careful spreading of each carload on the last one of the same approximate composition, and drawing from the end of the pile, will give such uniform charges that, with a good melter at the cupola, no anxiety need be had about the metal tapped out daily.

"This may be said to be the first benefit of the chemistry of iron to the founder, and he needs no laboratory for this on his own place, but simply a consultation with some one who knows what he requires in the first place, next careful sampling by a bright foreman or assistant and then a commercial analysis."

The next place where chemistry may be applied is in the purchase of coke, but here the matter has not made the same degree of progress. It is well understood that the presence of too much sulphur is detrimental to a foundry coke, and it is beginning to be realized that appearance and name are not in themselves sufficient guides in the selection of coke.

"As it is, you can specify and buy your coke with the sulphur down to 1 per cent., provided the makers will give it to you, and with a good coke or anthracite and uniform iron your charge on the cupola platform is as good as can be made, being the practical application of science directly where it pays well, and all this with a cost of but a few cents a ton added to the iron tapped at the cupola spout. As a simple matter of insurance this added expense should be granted by every foundryman, for it saves many a dollar otherwise wasted and lost, usually at a time when he can least afford it."

Passing to the use of the material thus selected, it may be asserted that a knowledge of the compositions of the irons employed will enable mixtures to be made from the analyses which will control the product. For this purpose the foundryman should know something of chemistry of the melting process, so that he may understand what changes will take place in the cupola, and he should know the composition of the scrap he uses as well as the pig. For specialties, such as car wheels, chilled rolls, malleable castings, and the like, the only way in which uniformity can be secured is by taking a daily analysis of practically every heat, especially for the silicon. In this way it has been found possible to take off 1,000 heats at a stretch without making any bad iron, the duration being only a matter of furnace repairs.

Dr. Moldenke touches upon the extent to which a proper use of chemistry in the foundry has widened the safe limits within which the daily work of the foundry can be conducted. Thus the co-relation of silicon and sulphur can be used in such a way that brands of iron containing the latter may be corrected by the presence of the former, while the total carbon in the metal may be reduced by the proper use of steel scrap. By these and similar methods materials may be used which would otherwise be considered entirely unsuitable for the production of satisfactory castings.

For many purposes the air furnace is being looked upon with increased favor for general foundry work, and in connection with the increasing use of the methods indicated by chemistry, Dr. Moldenke believes that the furnace may well replace the cupola. The absence of contact of the metal with the fuel insures a closer realization of the chemical reactions sought for in the mixture, and the improvement in the product is noteworthy.

"We Americans are said to appropriate every good idea we find on the other side of the water, and so we have taken Professor Turner's discovery of the action of silicon on the carbon in cast iron. We have taken Professor Ledebur's studies of the condition of the carbon in the malleable casting, and have pushed these inquiries far ahead in connection with our daily work. It is gratifying to see that now England and Germany are awakening to the importance of the chemistry of cast iron, and foundrymen's associations are being called to life, whose primary object is to study advanced methods of working. We wish them all possible success, and hope that their transactions may contain much new material that we can appropriate and amplify later on. A rivalry which means the freest interchange of information is a detriment to no one, and stimulates research as well as commercial enterprise. May we learn much more of the chemistry of iron in our foundry practice, and gradually clear away the doubtful portions which still remain to let us feel how little we really do know."

THE CIRCUM-BAIKALIEN RAILWAY.

COMPLETION OF THE CONNECTING LINK IN THE TRANS-SIBERIAN RAILWAY SYSTEM AROUND THE SHORE OF LAKE BAIKAL.

Glasers Annalen für Gewerbe und Bauwesen.

WITH the opening of the Circum-Baikalien section of the Trans-Siberian railway the completion of that great undertaking may be claimed, notwithstanding the fact that the Pacific terminal is at present involved in the deplorable interruptions of war.

This connecting portion of the road around the southern end of Lake Baikal has been deferred in construction beyond the rest of the railway because of the great difficulties presented, and because the traffic at the time of the opening of the line could readily be taken care of by the use of the train ferry across the lake.

Since the development of hostilities in Manchuria, and the necessity of maintaining continuous all-rail communication with the army during the winter season, efforts have been made to complete the railway connection, and the result has been the opening of the line for military service, thus practically completing the continuous railroad.

The total length of the railway connection around the lower end of the lake is 260 kilometres, and this has been divided into two separate construction undertakings. The first of these, extending from the station at Baikal around to Kultuk, a distance of 85 kilometres, offered the greatest obstacles to the work. In this portion the spurs of the Sayanskii Mountains skirt the lake, rising almost vertically from the shore to heights of more than 300 metres, and interrupted by ravines and gorges. The rock proved unsuitable for unsupported tunneling, and in nearly every case the borings required lining with masonry. In this section of 85 kilometres there were required 32 tunnels, having an aggregate length of 5.87 kilometres, and 210 bridges, viaducts and culverts. A number of deep cuttings were necessary, and these all required reinforcing with masonry retaining walls, while, as above stated, all the tunnels have been lined throughout. The longest tunnel is 800 metres in length, and all the tunnels have been made wide enough for double track, although but a single line has been laid at present. In this portion of the road the railway runs close to the shore of the lake, the tracks being at a level of 9.50 metres above the surface of the water. The second section, extending from Kultuk to Myssowsk, and connecting with the Manchurian railway at the latter point, offered fewer difficulties. The mountains here recede from the shore of the lake. so that but a single tunnel, of 80 metres in length, has been found necessary. The greatest trouble in this portion lay in the nature of the soil, this being marshy from frequent inundations from the lake, and traversed by numerous torrents running down from the mountains, necessitating bridges at points where it was difficult to secure good foundations. The railway in this portion of the route runs mainly upon an embankment, the width at the top being 5.54 metres, the sharpest curves being of 320 metres radius, and the steepest grade 1:125. In general the Circum-Baikalien section is better built than other parts of the Trans-Siberian, being laid with rails weighing 32.24 kilogrammes per metre, or about 65 pounds per yard. The bridges are steel trusses, on masonry piers, and the viaducts are built partly of steel and partly of masonry. Turnouts are provided at every 12 kilometres, permitting the operation of 14 trains in each direction every 24 hours.

In connection with the construction of the eastern section of the railway there has been built a branch line to the edge of the lake at Tanchoi, where a harbor has been constructed with complete accommodations for the great ice-breaking ferry boats now used in carrying the trains across the lake. This connection shortens the length of the lake trip for the ferry boats to about one-half of the old route from Baikal to Myssowsk, the boats making the trip only from Baikal to Tanchoi, where the coast portion of the railway is touched. There will thus always be a ferry communication available in case of any interruption upon the difficult portion of the line, and it is probable that this route may be regularly used in connection with merchandise traffic, especially when, as now, the full capacity of the railway is taxed for military purposes.

The intention to double-track the entire line of the Siberian railway is apparent from the fact that all the tunnels have been made of sufficient width to accommodate a double line of track, although but a single line has been laid at present. The double tracking of the entire line is even now progressing, and the extent to which this has been accomplished will be seen when it is understood that the sidings now in existence cover more than 1,000 miles of what will ultimately be the second line of track.

Some idea of the magnitude of the work will be gathered from the data as to the amount of material handled and the cost of the construction. From data in a recent issue of *Glasers Annalen*, from which this account is taken, it appears that the cuttings alone demanded the removal of 4,484,170 cubic metres of rock, these being hewn through the spurs of the mountains, and requiring continual blasting; while the tunnels involved the blasting and removal of 3,884,920 cubic metres of rock. The embankment in the second section of the line contains 9,760,860 cubic metres of earth and rock.

The total cost of the railway is given as 52,524,000 rubles, about $27,000,000, or £5,600,000, this corresponding to about $168.-000, or £35,000 per mile.

ALPINE RAILWAY BUILDING.

TUNNELLING AND PERMANENT-WAY CONSTRUCTION UPON THE UPPER SECTION OF THE JUNGFRAU ELECTRIC RAILWAY.

Paul Möller—Verein Deutscher Ingenieure.

SEVERAL months ago we gave some account of the progress which had been made during the past season upon the electric railway intended to reach the summit of the Jungfrau, and permit tourists in Switzerland to make the ascent with speed and comfort. We now have a further account of the work upon this interesting piece of Alpine railroading, by Herr Paul Möller, in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure,* from which we make some abstracts.

The starting point of the road is the station Kleine Scheidegg, on the Grindelwald-Lauterbrunnen railway, this line having been opened since 1893, and much frequented by tourists since then. This point is 2,064 metres above sea level, while the summit of the Jungfrau is more than double this altitude, being 4,166 metres above the sea, or 13,668 feet. The line winds up the mountain, with grades varying from 5 to 24 per cent., and passing through a tunnel of 80 metres in length, reaches the station Eigergletscher, a distance of 2 kilometres and an altitude of 2,323 metres, where the extended view of the surrounding glacier fields begins, the peaks of the Eiger, the Mönch and the Jungfrau all being visible. From this point on there are numerous tunnels, the grade remaining at about 25 per cent. until the station Eismeer is reached, about 5½ kilometres from the starting station, and 3,162 metres altitude. Beyond this point the road is not open to passenger service, although the construction work is progressing.

Just beyond the Eigergletscher station the road enters the principal tunnel, extending, with several openings to a point directly beneath the summit, from whence the peak is to be reached by a lift operated in a vertical shaft. One of the interesting features of this portion of the work appears in the extensive chambers which are hollowed out in the mountain at the stations, and from which openings are pierced in the walls, and observation balconies provided for the use of the travelers. Thus, from the station Eigerwand, at an altitude of 2,868 metres, an extended view over the Jura is obtained, and even to the distant Black Forest beyond.

The surveys for the upper section of the railway have been fully completed in all details as far as the Jungfraujoch station, and there remains but a small portion of the work to be done to the point of the elevator shaft. It is of interest to note that a portion of the topographical work was accomplished by the methods of photogrammetry, or photographic surveying, this being especially adapted for such a location.

An interesting portion of the work is found in the shops just beyond the Eigergletscher station. Here is a small machine shop, carpenter shop, and repair shop for the rock drills. Houses for the workmen are also provided, together with storehouses for material and provisions, the whole being intended to enable the working force to remain in comfort for months at a time without communication with the valley below. The possession of electric communication with the power house enables current to be available for power and for heating, this latter being used for the melting of ice for water, and for thawing dynamite.

The tunneling is conducted with three shifts of eight hours each, the workmen coming principally from northern Italy. The boring is being performed almost entirely by electric power, very little hand work being required, and although the operators are obliged to remain at high altitudes for several months at a time there has not been any apparent development of mountain sickness.

Herr Möller describes in detail the construction of the electric locomotives and rolling stock, as well as the hydro-electric station at Lauterbrunnen, but these have already been discussed in these columns. The whole undertaking is an excellent example of the manner in which electric power development, together with applications of electric traction methods, are being applied to open up ways of communication which could hardly have been profitably undertaken under older systems.

An interesting feature of the Jungfrau railway appears in the fact that at every point the road is made with sufficient incline to enable the train to descend by gravity alone, this insuring a safe return to the valley below in case of any accident which might cut off or interrupt the electric power.

THE EQUIPMENT OF THE ENGINEER.

A CHARACTERISTIC ADDRESS DELIVERED BEFORE THE STUDENTS OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

James Swinburne—The Electrician.

LAST month we reviewed in these pages the suggestive address of Mr. Kerr, delivered before the students of the Stevens Institute of Technology, in which some of the difficulties with which the practising engineer has to contend were placed before the beginner. We now have a somewhat similar presentation of the practical side of engineering work in the form of an address by Mr. James Swinburne before the students of the Institution of Electrical Engineers. From a report of this address published in a recent issue of the *Electrician* we make some abstract and review, and a comparison between the views of two such practical men upon such similar occasions cannot fail to be of interest alike to students and to Engineers.

Upon the much-discussed subject of general and special knowledge, Mr. Swinburne takes a rather conservative position.

"Probably each man should have a general knowledge of applied physics and chemistry and mathematics, and a special knowledge of one or two subjects. The special knowledge may never come in useful; but the chances are that in the blind stumblings we call our careers a specialty may be very valuable. If you glance round at the work of some of our big men you will be surprised to see how many have made their reputation by doing one small thing, but doing it well. If a man gets to the front in one narrow subject the world credits him with knowledge of all the rest. It is, however, even easier to acquire a large general knowledge than an advanced special knowledge of one narrow subject. The specialty must not be too narrow either."

That all knowledge is valuable for the uses to which it can be put, is emphasized in a very characteristic manner. It is undoubtedly true that much time and labor has been expended in the past upon studies which were regarded at the time as worthy departments of pure science, but which have long since been abandoned because they have been shown to be based upon false principles.

"Science, for which no use has been found, or which is not applied, is called 'pure science,' whereas it is really the raw material, and should be called 'raw' or 'crude science.' There is an assumption of superiority in the term 'pure science,' and generally the term 'science' is appropriated by workers in raw science in much the same way as the term 'workingman' is appropriated to the exclusion of brain workers. There is supposed to be something noble and superior about 'raw science,' and its study is treated as the unselfish devotion to the interests of man, which is obviously entirely the wrong way round. The so-called 'scientific man' thinks that engineers and manufacturers are ignorant and unscientific, and that their practical knowledge is of no account; and that the cure for all industrial evils is more technical education, more universities and more power to the science masters. Though there are in existence a few practical science teachers they are rare. Perhaps no one would be more surprised than the average science master if you told him he was unpractical, and was, by his attitude and example, hindering science. He does not mean to. He is as keen as possible to do just the reverse, and is generally exceedingly anxious for the spread of science or technology; but, unfortunately, he has got a wholly wrong view of the relations of science and business. There is no more baneful influence on the technical advancement of this country than the Royal Society ideal in science."

The keynote of Mr. Swinburne's address, however, lies in the position which he takes concerning the relations of the scientific engineer and the business man.

"I would earnestly urge any of my hearers who has the idea that there is something noble and superior about 'raw science,' or who thinks little of business men, to get rid of all such notions if he hopes ever to get on. If you look round the electrical industry, or round the industries generally, who are at the top? Always the business man. The men at the head of large industries generally know very little science. A man may run a large electrical industry with the most vague ideas as to the true relation of the electrostatic and electromagnetic systems of units; in fact, he may think power, force and energy are very much the same kind of thing if looked at in a broad common-sense way without any scientific prejudice. If he wants good technologists he employs them. If he wants practical men who can take commercial responsibility he pays good salaries; if he wants men full of book knowledge he pays low salaries, but he does not generally want them. Raw scientists, to coin a horrible word for a most estimable class, tell him he knows nothing about science, and therefore does not know how to run a scientific business, and tell him to subscribe to universities, which are so inefficiently worked that they have to beg, like hospitals, and to employ young men from the technical colleges. He either takes no notice or he gets annoyed at their superior attitude, and discharges a couple of scientific men and puts their saved wages toward the salary of a new practical chauffeur, and enjoys himself."

"A man's value to the world at large may generally be roughly estimated by the income he earns. Where position is earned at the same time, the money income is in proportion less for a given usefulness; but taking such disturbing elements into account, the rule is broadly true. The business man comes out far away above the engineer. He employs the engineer; the scientific man is his servant. Just as the raw scientist looks down on the engineer, and the engineer looks down on the business man, so the business man has a contempt for the engineness; and the engineer in his turn looks on the raw scientist as an unpractical crank. So much is this the case that the business man will not trust the engineer more than he can help. He assumes that if you know anything about anything you cannot possibly be a business man."

That the engineer cannot be a successful business man is by no means the idea everywhere. In fact, it is now very generally recognized in the United States that a scientific training is an excellent qualification for a business career. The positions of the heads of great railroads, manufacturing companies, and industrial enterprises are in many instances filled by men who have risen from engineering positions, and who are applying the methods of engineering science to commercial problems. Productive commercial enterprises have come to be so closely identified with engineering operations and methods that it is beginning to be very well recognized that there is no training possible which fits a man better for business success than the training of the engineer.

An excellent example of this fact is seen in the manner in which men with engineering training have entered the great workshops of the United States and have, by revolutionizing and reorganizing the methods devised by the older business men, succeeded in increasing the output, improving the quality of the product, and curtailing the losses, simply by an intelligent application of scientific engineering methods to operations formerly conducted according to the ideas of the old-time business man. In England the "production engineer" has not yet attained the prominence which exists in America, but he is not altogether unknown, and there is ample room for him and his work in a field as yet all too little cultivated.

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a Descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every article.

(1) The full title,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published.

We supply the articles themselves, if desired.

The Index is conveniently classified into the larger division of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering 687
Electrical Engineering 693
Industrial Economy 697
Marine and Naval Engineering..... 698
Mechanical Engineering 701
Mining and Metallurgy 708
Railway Engineering 713
Street and Electric Railways....... 716

CIVIL ENGINEERING

BRIDGES.

Arches.

The Economical Construction of Large Stone Bridges (Construction Economique des large Ponts en Pierre). M. Sejourné. Showing the advantages of using two narrow arches instead of a single wide arch, as in the case of the Luxembourg and Toulouse bridges. 4000 w. Rev Gen d Chem de Fer—Oct., 1904. No. 66229 G.

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Cantilever.

The Erection of the Double Track Mingo Cantilever Bridge Over the Ohio River. An illustrated description of an unusually difficult undertaking; a 700 ft. channel span crossing the Ohio River. 2000 w. Eng Rec—Nov. 26, 1904. Serial. 1st part. No. 66343.

Drawbridge.

The Calumet River Drawbridge, Baltimore and Ohio R. R. Illustrated description. 1000 w. Eng Rec—Nov. 26, 1904. No. 66349.

Highway Bridge.

The Bellows Falls Highway Bridge. An illustrated description of a large highway arch span across the Connecticut River, the only long-span arch with suspended floor in the United States. 2500 w. Eng Rec—Nov. 5, 1904. No. 65948.

The Comparative Economy of Various Types of Highway Bridges. C. B. Wing. Outlines a method for determining the most economical bridge for a given location. 2000 w. Jour Assn of Engng Socs—Sept., 1904. No. 66170 C.

Maastricht.

The Erection of the Bridge Over the Maas at Maastricht (Herstellings-werken aan de Brug over de Maas te Maastricht). Ch. Driessen. Illustrated account of the erection of a lattice truss railroad bridge at Maastricht, Holland, the two principal spans being 100 metres long each. 4000 w. De Ingenieur—Oct. 8, 1904. No. 66278 D.

Reconstruction.

The Swale Bridge. Illustrated description of an interesting piece of reconstruction work on the Southeastern and Chatham Railway. A bascule bridge span was replaced by a Scherzer rolling-lift type. 500 w. Engng—Nov. 11, 1904. No. 66300 A.

Reinforced Concrete.

Crossing Bridge of Reinforced Concrete (Bahnübergangssteg aus Betoneisen). Ludwig Stuppacher. Illustrating a Monier arch foot bridge over double-track railway line, with details of construction. 6000 w. 2 plates. Oesterr Woschenschr f d Oeffent Baudienst—Oct. 15, 1904. No. 66265 D.

Reinforced Concrete Bridge Over the Isar at Grünwald Above Münich (Strassenbrucke in Eisenbeton über die Isar vei Grünwald Oberhalb München). Illustrating and describing a highway bridge with two spans of 70 metres each, with hinges at the crown and springings. Three articles. 3000 w. Deutsche Bauzeitung—Oct. 5, 12, 19, 1904. No. 66266 each B.

Tests of a Ferro-Concrete Bowstring Bridge. Illustrated article reporting tests made of a 60-ft. bowstring bridge erected at Purfleet. 900 w. Engng—Oct. 28, 1904. No. 65984 A.

See also Civil Engng., Construction.

Renewals.

Renewing Bridges on the West Shore. An illustrated article giving information regarding the extensive bridge renewals in the course of improving this road for heavy traffic. 1500 w. R R Gaz—Vol. XXXVII, No. 23. No. 66160.

Rhine.

New Bridge Near Mayence. Illustrations, with brief description of a bridge making a direct connection between the railways on the right and left banks of the Rhine. 700 w. Engr, Lond—Nov. 11, 1904. No. 66303 A.

Sunderland.

New Railway and Road Bridge Over the River Wear at Sunderland. Francis E. Harrison. Illustrates and describes a new bridge for both railway and road purposes, with main span of 330 feet. 2000 w. Transport—Nov. 18, 1904. No. 66353 A.

Suspension.

A New Type of Rigid Suspension Bridge. Translation of an article by Commandant Gisciard, in the *Genie Civil.* Illustrated description of a type of which three bridges have been built in the French Congo, and one is under construction in the Pyrenees. 3000 w. Eng Rec—Nov. 5, 1904. No. 65951.

The Elisabeth Suspension Bridge at Budapest (Le Pont Suspendu Elisabeth à Budapest). A. Bidault des Chaumes. A fully illustrated account of the new eyebar suspension bridge of 290 metres span across the Danube. 2500 w. 1 plate. Genie Civil—Oct. 15, 1904. No. 66211 D.

Thebes.

The Thebes Bridge. Illustrated description of a double-track railroad bridge across the Mississippi River, now nearing completion. 1500 w. Eng Rec—Nov. 12, 1904. No. 66026.

Williamsburg Bridge.

Electrifying the New Williamsburg Bridge. Brief illustrated description of electrical equipment of the double tracks on this East River bridge at New York. 600 w. St Ry Jour—Nov. 19, 1904. No. 66182 C.

Wreck.

Repairing a Wrecked Drawbridge Over the Maumee River at Toledo. An illustrated account of the wrecking of a drawbridge on the Wheeling & Lake Erie R. R. by a steamer, and the repairs. 1000 w. Eng Rec—Nov. 19, 1904. No. 66152.

CONSTRUCTION.

Buildings.

The Structural Design of Buildings. Discussion of a paper by C. C. Schneider. 12000 w. Pro Am Soc of Civ Engrs—Nov., 1904. No. 66368 E.

Dining Hall.

Steel Details of a Large Dining Hall. Illustrates and describes details of the dining hall for the Middletown State Hospital for the Insane. 1600 w. Eng Rec—Nov. 5, 1904. No. 65952.

Efflorescence.

On the Saline Efflorescence of Bricks. Oscar Gerlach, in the *Brickbuilder*. Discusses the causes leading to it, and the practical means of avoiding the same. 3000 w. Stevens Ind—Oct., 1904. Serial. 1st part. No. 66409 D.

Floors.

Fireproof Floor Construction. J. T. Montgomery. Remarks on concrete construction, explaining the application of this material to the protection of structural steel in buildings, its advantages and disadvantages. Ills. 2700 w. Jour W Soc of Engrs—Oct., 1904. No. 66094 D.

Standard Floor Arch Construction. E. V. Johnson. General remarks on the standard floor arch construction, with statement of the advantages of the standard steel and tile construction. Discussion. 7700 w. Jour W Soc of Engrs—Oct., 1904. No. 66095 D.

Pile Driving.

Observations on Driving Piles with a Steam Hammer. J. J. Welsh. Describes work in San Francisco, explaining the conditions. 1000 w. Jour Assn of Engng Socs—Sept., 1904. No. 66172 C.

Reinforced Concrete.

A New Method of Building Construction. S. Giletti. Illustrates and describes a method of building walls, partitions and floors in which the metallic frame is inserted in flues left open for this purpose, the walls being built first, and then filled in, binding the whole in a solid mass. 1500 w. Jour Assn of Engng Socs—Sept., 1904. No. 66168 C.

A Rèsumè of Some Tests on Concrete Steel Beams. J. Kahn. A report of tests made by the writer, repeating tests made by Prof. A. M. Talbot. 2500 w. Cement—Nov., 1904. No. 65954 C.

Concrete Steel. M. C. Couchot. A short description of this system of construction, its recent applications in the United States and its advantages. 1800 w. Jour Assn of Engng Socs—Sept., 1904. No. 66167 C.

The Parkville Concrete-Steel Substation of the Brooklyn Rapid Transit Co. Illustrated detailed description. 3000 w. Eng Rec—Nov. 26, 1904. No. 66345.

See Also Civil Engineering, Bridges.

Roads.

Road Building in the Far North. C. W. Purington. An account of road building in Alaska, the conditions, difficulties, costs, etc. 1600 w. Eng & Min Jour—Nov. 24. 1904. Serial. 1st part. No. 66326.

Steel Framing.

The Steel Framing of the New Amsterdam Theatre, New York. Illustrated description of interesting structural features in a steel-cage fireproof building covering about 17,500 sq. ft. of ground surface. 1800 w. Eng Rec—Nov. 19, 1904. Serial. 1st part. No. 66155.

Steel-Work.

Special Steel-Work in Orchestra Hall, Chicago. Drawings, photographs and description. 3500 w. Eng News—Nov. 3, 1904. No. 65923.

Tunnels.

Great Northern Tunnel at Seattle. Illustrated detailed description of the tunnel, nearly a mile long, being driven under the business section of the city. 1300 w. R R Gaz—Vol. XXXVII, No. 22. No. 66005.

The Construction of the Simplon Tunnel (Der Bau des Simplon Tunnels). Paul Möller. A description of the methods of working, drainage, ventilation, and timbering of the later portions of the tunnel. 4500 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1904. No. 66205 D.

The Remarkable Progress of the Hudson River Tunnel for the New York and New Jersey R. R. Co. A brief illustrated account of the methods of construction and the progress of the work. 1000 w. Eng News—Nov. 10, 1904. No. 65999.

Underpinning.

Concealed Underpinning for a New York Residence. Describes the damage to a building on the corner of 38th st. and Park ave., New York, caused by the construction of the tunnel for the Rapid Transit Ry., and the method of underpinning devised to support the building until the new foundations are built. Ills. 900 w. Eng Rec—Nov. 26, 1904. No. 66347.

MATERIALS OF CONSTRUCTION.

Asphalt.

Asphalt. Thomas B. Stillman. Its occurrence, composition, adulterations, and commercial uses, with schemes for its analysis. 1200 w. Stevens Ind—Oct., 1904. No. 66407 D.

Cement.

Manufacture and Testing of Portland Cement. C. J. Wheeler. Reviews briefly the history of cement manufacture, describing present practice and giving information of interest. 4000 w. Jour Assn of Engng Socs—Sept., 1904. No. 66169 C.

Notes on Lutes and Cements. Samuel S. Sadtler. Treats of kinds of lutes and cements most likely to be used by engineers, and arranged according to the intended application. 2800 w. Pro Engrs' Club of Phila—Oct., 1904. No. 66067 D.

The Cement Exhibits at the St. Louis Exhibition. Illustrated description of the cement building, model testing laboratory, and other exhibits. 3000 w. Eng News—Nov. 10, 1904. No. 65996.

Cement Mill.

A Gravity Cement Mill in the Pyrenees. G. M. Peek. A fully illustrated account of the construction and mechanical equipment of a mill driven by hydraulic power, and utilizing gravity in the movement of material. 3000 w. Engineering Magazine—Dec., 1904. No. 66285 B.

Fire-Brick.

Refractoriness of Some American Fire-Brick. R. F. Weber. Gives results obtained in testing a series of fire-brick from different parts of the country, in order to determine the relation of their chemical composition, refractoriness and texture. 3500 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 66359.

Plaster.

Plaster-of-Paris (Le Plâtre). J. Malette. A general discussion of the nature and properties of calcined gypsum as a material of construction. 3000 w. Revue Technique—Oct. 25, 1904. No. 66221 D.

Reinforced Concrete.

See Civil Engineering, Bridges, Construction.

Road Materials.

The Cementing Power of Road Materials. Logan Waller Page and Allerton S. Cushman. Reports the results of researches made by the Bureau of Chemistry, U. S. Dept. of Agriculture. 3500 w. Eng News—Nov. 17, 1904. No. 66131.

Timber Preservation.

Two New Timber Preservation Processes at the St. Louis Exhibition. Describes the Rueping process, and Giussani process. 1800 w. Eng News—Nov. 17, 1904. No. 66127.

MEASUREMENT.

Surveying.

A Universal Angle-Measuring Instrument (Universal Winkelinstrument). A. Mayer and E. Wiesmann. Illustrating an improved form of engineer's transit, adapted for tunneling and general railway work, and designed in connection with the work on the Simplon tunnel. 2000 w. Schweiz Bauzeitung—Oct. 15, 1904. No. 66250 B.

Wind Pressure.

Probable Wind Pressure Involved in the Wreck of the High Bridge Over the Mississippi River, on South Avenue, St. Paul, Minn., August 20, 1904. C. A. P. Turner. An illustrated article describing the bridge, and outlining the collapse, with calculation of the pressure. 2000 w. Pro Am Soc of Civ Engrs—Nov., 1904. No. 66366 E.

MUNICIPAL.

Joints.

The Use of Sulphur for Sewer-Pipe Joints in Wet Trenches. E. S. Rankin. Describes a plan used by Alexander Potter, of joining pipes with a mixture of melted sulphur and fine sand, and since used by the writer experimentally for securing water-tight work. 1700 w. Munic Engng—Nov., 1904. No. 65902 C.

Laboratory.

A Municipal Laboratory for Testing Asphalt and Cement. W. H. Broadhurst. Illustrated description of a plant designed for testing asphalts, paving materials, cements, etc., and the facilities for testing. 2000 w. Munic Engng—Nov., 1904. No. 65900 C.

Pavements.

Granite Asphalt Paving (Le Granite Asphalte). Col. G. Espitallier. Describing the use of a mixture of crushed granite and asphalt for surfacing pavements, as used in the Place de l'Opera, at Paris. 1500 w. Génie Civil—Oct. 29, 1904. No. 66215 D.

Tests for Wood Paving Blocks. F. A. Kummer. Considers in detail the specifications prepared by George W. Tillson for work of this class. 2000 w. Munic Engng—Nov., 1904. No. 65901 C.

Refuse.

The Disposal of Municipal Refuse. F. K. Rhines. Discusses the various classes of refuse and the difficulties of disposing of each, and why some methods succeed while others fail. 6500 w. Jour Assn of Engng Socs—Oct., 1904. No. 66400 C.

Sewage Disposal.

Sewage Disposal for Small Cities and Towns. T. Chalkley Hatton. Outlines several systems used for sewage purification, the choice depending on the character of the sewage. 3300 w. Munic Engng—Nov., 1904. No. 65897 C.

Sewage Disposal. J. N. McClintock. Describes a plant at a seaside cottage to prevent pollution of the water where sea-bathing is permissible. 1200 w. Munic Engng—Nov., 1904. No. 65898 C.

The Disposal of Sewage Sludge at Saltley, England. George A. Hart. Illustrated description of a recent experience in sewage and sludge disposal at the Saltley outfall works of the Birmingham, Tame and Rea District Drainage Board. 3500 w. Eng Rec—Nov. 5, 1904. No. 65949.

Sewage Testing.

The Sewage Testing Station at Columbus, Ohio. John H. Gregory. Brief remarks on the extensive improvements planned, with illustrated description of the testing station. 2500 w. Eng Rec—Nov. 19, 1904. No. 66153.

Sewers.

Some Examples of Recent Main Sewer

Construction by the City of Philadelphia. C. H. Ott. Illustrates and describes the types of construction. Discussion. 2200 w. Pro Engrs' Club of Phila—Oct., 1904. No. 66066 D.

The Cleaning and Flushing of Sewers. Discussion by the Sanitary Section of the Boston Society of Civil Engineers at the meetings of March 2 and April 13, 1904. 23400 w. Jour Assn of Engng Socs—Oct., 1904. No. 66399 C.

The Design of a Main Outfall Sewer. Notes from a paper by W. H. Haigh, in the Pro. of the Inst. of Civ. Engrs., concerning a sewer leading to Bristol Channel from one of the three drainage districts of Cardiff. 1000 w. Eng Rec—Nov. 19, 1904. No. 66154.

The Sewerage System of Little Rock, Ark. Walter F. Reichardt. Explains the method of making improvements in this city, and the present condition of the sewerage system. 2200 w. Munic Engng—Nov., 1904. No. 65899 C.

Sewer Ventilation.

The Shone System of Fan Ventilation of Sewers at Darley Abbey and at Leicester, England. Describes a system of sewer ventilation by means of a fan on an extraction shaft and specially designed air inlets at the top of vertical shafts. 2500 w. Eng News—Nov. 24, 1904. No. 66334.

WATER SUPPLY.

Coolgardie.

The Coolgardie Water Works. Illustrated description of the water works scheme for supplying the mines of Western Australia. 3500 w. Sci Am Sup—Nov. 12, 1904. No. 66010.

Corrosion.

Electrolytic Corrosion of Water Pipes at Bayonne, N. J. Abstract of results of an investigation made by A. A. Knudson, which reveals serious conditions as to stray electric railway currents and electrolytic corrosion of underground metals. Ills. 3000 w. Eng News—Nov. 17, 1904. No. 66130.

Dam.

Cataract Dam for the Additional Water Supply of Sydney, N. S. W. Illustrates and describes new works to increase the supply for this Australian city, and the methods of construction. 2700 w. Eng Rec—Nov. 5, 1904. No. 65947.

The Charles River Dam and Lock at Boston. John N. Ferguson. Illustrated article showing the location, arrangement and style of construction of the dam and work in connection. 2500 w. Eng Rec—Nov. 26, 1904. No. 66346.

Extensions.

The Odessa Water Works. An illustrated article describing new extension to supplement the old plant at Odessa, Russia, with the most modern and economical machinery. 1500 w. Engng—Nov. 4, 1904. No. 66053 A.

Filtration.

The Mechanical Filters of the Hackensack Water Company. Illustrated description of the purification works. 3000 w. Eng Rec—Nov. 12, 1904. Serial. 1st part. No. 66028.

The Roofing of the Washington Filters. E. D. Hardy. Illustrated description of the methods of construction. 1500 w. Eng Rec—Nov. 5, 1904. No. 65950.

Frozen Pipes.

Thawing Out Frozen Water Pipes Electrically. William Maver, Jr. Reviews plumbers' methods of thawing, and gives an illustrated description of the electrical method and related information of interest. 3000 w. Cassier's Mag—Nov., 1904. No. 66063 B.

Ground Water.

The Progressive Sinking of the Ground Water Level and Artificial Ground Water Supplies. Prof. J. Gustav Richert. A discussion of the effect of wells on ground water supplies, and concluding that artificial infiltration is the best solution of the problem. Ills. 2000 w. Eng News—Nov. 24, 1904. No. 66333.

The Sources of the Utrecht Water Supply (De Prise d'Eau van de Utrechtsche Waterleidung). P. E. Rijk. With plan of the location of the pipe, wells and chart of the ground-water levels from 1885 to 1904. 2000 w. 1 plate. De Ingenieur—Sept. 24, 1904. No. 66277 D.

Lead Pipe.

The Use of Lead Pipe for Conveying Drinking Water (Verwendung von Bleiröhren bei Trinkwasserleitungen). Adolf Siegmund. An examination of the conditions under which drinking water may be rendered unwholesome by passing through unlined lead pipes. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 21, 1904. No. 66222 D.

Mains.

Scraping Water Mains at Melbourne. Information concerning this work taken from a paper by Edgar G. Ritchie. published by the Inst. of Civ. Engrs. 1500 w. Eng Rec—Nov. 26, 1904. No. 66344.

Pumping Machinery.

See Mechanical Engng., Hydraulics.

Reservoirs.

The Failure of a Small Brick Reservoir at Winston, N. C. J. L. Ludlow. Brief, illustrated description. 900 w. Eng News—Nov. 17, 1904. No. 66132.

The New High Service Reservoir at Holyoke, Mass. Illustrates and describes a recently completed dam and reservoir to supply water to the elevated portions of this city of 50,000 inhabitants. 1800 w. Eng Rec—Nov. 26, 1904. No. 66348.

River Pollution.

The Collection of River Waters for Investigation (Probeentnahme apparate für Flussuntersuchungen). Dr. Schumacher. An exhaustive account of the various devices for taking samples of river water for examination for hygienic purposes. Three articles. 7000 w. Gesundheits Ingenieur—Sept. 20, 30, Oct. 10, 1904. No. 66262 each B.

The Pollution of the Passaic River and Its Prevention. Ernest Adams. Gives a full account of the trouble from the pollution of this river of New Jersey, and the correction. 3500 w. Munic Engng—Nov., 1904. No. 65896 C.

Vienna.

The Water Supply of Vienna (Die Wasserversorgung Wiens). Josef Riedel. A general account of the various sources of supply, with map and profiles. 3000 w. 2 plates. Oesterr Wochenschr f d Oeffend Baudienst—Oct. 22, 1904. No. 66279 D.

Water Tower.

The Million-Gallon Water Tower of the East Providence Water Company. Illustrated description of a very large new tower which furnishes storage for fire protection and other purposes. 1700 w. Eng Rec—Nov. 12, 1904. No. 66031.

WATERWAYS AND HARBORS.

Canals.

Preliminary Engineering Work on the New York Barge Canal Improvements. Reviews a manual of instructions recently issued by H. A. Van Alstyne, State Engineer, for preliminary work on the improvement of the Erie, Oswego and Champlain Canals. 2200 w. Eng Rec—Nov. 12, 1904. No. 66029.

The Projected New Canal from the River Rhine to the City of Hanover. Describes the project, and gives a summary of the advantages promised. Map. 1600 w. Ir & Coal Trds Rev—Nov. 4, 1904. No. 66046 A.

Channel Ports.

The Principal Ports on the Channel (Les Principaux Ports de la Manche). R. Bonnin. Describing the improvements completed and in progress at the ports used in connection with the trafic between France and England. Serial. Part I. 2000 w. Revue Technique—Oct. 25, 1904. No. 66218 D.

Dock.

Floating Dock of 11,500 Tons Capacity (Schwimmdock von 11,500 t Tragfähigkeit). W. Kaemmerer. Describing a new floating dock built by the Gut-hoffnungohütte for use at Hoboken, near Antwerp. 1500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Oct. 22, 1904. No. 66202 D.

Dock Yards.

One of Japan's Dock Yards. Illustration, with description of the Mitsu Bishi dock yard and engine works at Nagasaki. 1500 w. Stevens Ind—Oct., 1904. No. 66404 D.

Dredges.

Combined Bucket and Suction Dredge Constructed for the Government of Uraguay. Illustrated description of this interesting self-propelled suction dredge. 1000 w. Marine Engng—Nov., 1904. No. 65852 C.

The Steam Dredge Vulcan. Illustrated description of a powerful dredger designed to meet the requirements of the Mersey Dock and Harbor Board for deep dredging in hard material, and for working close up to the dock and quay walls. 1200 w. Engr, Lond—Oct. 28, 1904. No. 65986 A.

Dry-Docks.

Temporary Dry-Docks for Rapid Construction. V. E. Timonoff. Read before the Int. Engng. Cong. at St. Louis. Indicates one of the possible solutions of repairing damaged vessels, describing a method of constructing a temporary dry-dock. 2800 w. Marine Engng—Nov., 1904. No. 65854 C.

The Development of Dry-Dock Pumping Machinery. J. S. Shultz. With numerous illustrations showing the increasing and advantageous use of centrifugal pumps in dry-dock operation. 3500 w. Engineering Magazine—Dec., 1904. No. 66284 B.

Mississippi.

The Reclamation of River Deltas and Salt Marshes. J. Francis Le Baron. Shows the desirability of reclaiming such lands, especially at the mouth of the Mississippi, and along the whole seaboard. An illustrated study of the treatment. 8500 w. Pro Am Soc of Civ Engrs—Nov., 1904. No. 66367 E.

Narvik.

The Railway Terminus and Port at Narvik, Norway (Le Chemin de Fer el le Port de Narvik). Charles Delgobe. An account of the important harbor works at the Atlantic terminal of the Luleo-Narvik railway, communicating with the iron ore deposits of Lapland. 3000 w. 1 plate. Génie Civil—Nov. 5, 1904. No. 66216 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Aerial Wires.

Lightning Rods, Wireless Telegraphy and the Dispersion of Fogs by Electricity. A. Frederick Collins. A short review of the use of wires for the first two purposes, with comparison with the third use named. Describes the investigations for the dispersion of fogs. 2800 w. Elec Wld & Engr—Nov. 26, 1904. No. 66376.

Alaska.

The Alaskan Telegraph. George C. Maynard. The history of the Alaskan telegraph from its inception in 1865 to its successful working in October, 1904. Ills. 4200 w. Elec Rev, N. Y.—Nov. 12, 1904. No. 66034.

Cables.

Methods of Cable-Laying. Leonard Andrews. A summary of the advantages and disadvantages of some of the systems that have been most largely used. 1400 w. Elec Engr, Lond—Nov. 18, 1904. No. 66380 A.

The Laying of the Commercial Pacific Cable. Frank P. Medina. Describes points of design and construction, laying and maintenance of submarine cables, with special reference to the Commercial Pacific Cable Company's cable between San Francisco and Manila. 3500 w. Jour Assn of Engng Socs—Sept., 1904. No. 66162 C.

Conductors.

The Transposition of Electrical Conductors. Frank F. Fowle. Mathematical and practical discussion of the transposition of telephone and of power circuits to prevent inductive interferences and cross-talk. 4400 w. Trans Am Inst of Elec Engrs—Nov., 1904. No. 66090 D.

Printing Telegraph.

Siemens & Halske Printing Telegraph or Telecryptograph. L. Ramakers. Illustrated detailed description of this automatic telegraphic system. 2500 w. Sci Am Sup—Nov. 19, 1904. No. 66116.

Space Telegraphy.

The Installation of Wireless Telegraphy at the Marine Yard at Amsterdam (De Inrichtung voor Draadlooze Telegrafie aan de Marinewerf te Amsterdam). J. C. van Iterson. A general review of the present status of space telegraphy, with special reference to the Amsterdam installation. 3000 w. De Ingenieur—Sept. 10, 1904. No. 66274 D.

Thermo-Electric Receivers for Wireless Telegraphy and Telephony. Illustrates and describes some new and interesting arrangements devised by Prof. André Blondel. 2000 w. Sci Am Sup—Nov. 12, 1904. No. 66011.

Wireless Telegraphy on Mail Steamers. Emile Guarini. An account of how secrecy is secured on the Belgian mail packets. 1700 w. Elec Rev, N. Y.—Sept. 19, 1904. No. 66157.

DISTRIBUTION.

Alternating Current.

The Superiority of Alternating Current for the Supply of Current to Large Cities. Dr. Gotthold Stern. Abstract of a paper read before the St. Louis Int. Elec. Cong. Presents arguments favoring the alternating current. Also editorial. 6500 w. Elect'n, Lond—Oct. 28, 1904. No. 65980 A.

Cables.

The Theory of the Heating of Cables (Zur Theorie der Kabelerwärmung). J. Teichmüller. Deriving formulas for use in computing the rise in temperature of underground cables for various currents. 4000 w. Elektrotech Zeitschr—Nov. 3, 1904. No. 66239 B.

Conducting Systems.

Grounded Transmission Mediums. J. Stanley Richmond. This first of a series of articles is mainly historical, referring principally to England. Succeeding articles will deal with earth potential measurements, track drops, stray transmission, tracks and bonding. 1800 w. Elec Rev, N. Y.—Nov. 26, 1904. Serial. 1st part. No. 66339.

Faults.

Notes on Faults in Small Lead-Covered Wires. Donald Smeaton Munro. Discusses dangers due to defects of manufacture, and disadvantages after erection. Ills. 1400 w. Elec Rev, Lond—Oct. 28, 1904. No. 65979 A.

Networks.

The Computations for Open Networks (Die Berechnung Offener Stromverzweigungen). Dr. E. Müllendorff. Deriving formulas for proportioning the members of a distribution network so that the volume of the conductors shall be a minimum. 2000 w. Zeitschr f Elektrotechnik—Oct. 16, 1904. No. 66244 D.

Relay.

An Alternating Current Relay for Low Frequencies. Frank F. Fowle. Describes an invention of the writer, designed to operate on circuits of 16 2/3 cycles with a very small consumption of energy. 1200 w.

Elec Wld & Engr—Nov. 19, 1904. No. 66185.

Safety Appliances.

The Construction of Electric Safety Appliances for Weak Currents (Beitrag zur Konstruktion Elektrischer Sicherungen für Schwachstromanlagen). Hans Carl Steidle. A coherer is employed to operate a cut-out in case of any sudden change in current. 3500 w. Elektrotech Zeitschr—Nov. 3, 1904. No. 66240 B.

Switches.

American Switch Systems (Ueber Amerikanische Schaltanlagen). Artur Hruschka. A general account of American switchboard construction as applied in traction plants, long-distance transmission systems, and general service. Two articles. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 28, Nov. 4, 1904. No. 66223 each D.

Wiring.

Some Hints on Conduit Work. T. F. McMackin. Illustrated discussion of some of the difficulties met with. 1100 w. Am Elect'n—Nov., 1904. No. 65911.

ELECTRO-CHEMISTRY.

Anode Films.

Colloidal Precipitation Upon Aluminium Anodes. William Roy Mott. An explanation of phenomena in the anode film, based on extended experimental investigations. 3000 w. Elec-Chem Ind—Nov., 1904. No. 65883 C.

Electric Furnaces.

Refractory Materials in Electrical Resistance Furnaces. F. A. J. Fitzgerald. Deals with finding a satisfactory refractory material for lining electric furnaces, giving much information concerning methods of employing the materials recommended. 6000 w. Elec-Chem Ind—Nov., 1904. No. 65882 C.

Electric Smelting.

See Mining and Metallurgy, Iron and Steel.

Electrolysis.

Some Examples of Catalytic Action in Electrolysis. C. J. Thatcher. Illustrates the use of catalytic agents in analyzing electrode processes; and the practical use to which such agents may be put in synthetic electrolyses. 1800 w. Elec-Chem Ind—Nov., 1904. No. 65884 C.

The Theory of the Separation of Metals from Rapidly Moving Electrolytes (Zur Theorie der Metallabscheidung aus Stark Bewegten Elektrolyten). R. Amberg. Showing the influence of current density, degree of concentration and speed of circulation upon the rate of deposit. 1800 w. Zeitschr f Elektro-Chemie—Nov. 4, 1904. No. 66248 G.

Electro-Metallurgy.

An Electrochemical Process for the Treatment of Silver Sulphides and Gold Ores. M. Vaygouny. An account of experimental investigations made upon ores which carry their values chiefly as silver sulphides with certain amounts of gold. 3300 w. Elec Rev, N. Y.—Nov. 5, 1904. No. 65937.

Electric Furnace for the Metallurgy of Copper. Translated from *La Nature*. Brief, illustrated account of the invention of M. Imbert de Vanoy. 600 w. Sci Am Sup—Nov. 26, 1904. No. 66310.

Storage Batteries.

See Electrical Engineering, Generating Stations.

ELECTRO-PHYSICS.

Atmospheric Resistance.

The Law of Atmospheric Resistance to Electric Discharges (Ueber das Elektrische Durchschlagsgesetz für Atmosphärische Luft). Hugo Grob. A study of experiments made at the Oerlikon Works, in Switzerland, with pressures up to 105,000 volts. 1800 w. Elektrotech Zeitschr—Nov. 10, 1904. No. 66241 B.

Radio-Activity.

On the Radio-activity of Natural Waters. Bertram B. Boltwood. Describes a method for the quantitative determination of the radio-active gas contained in a water and a convenient standard for measurement and comparison. Ills. 4000 w. Am Jour of Sci—Nov., 1904. No. 65886 D.

Testing.

Magnetic Testing of Iron and Steel. Statements from the report of the committee of the American Society for Testing Materials appointed to investigate the magnetic testing of iron and steel. 1500 w. Elec Wld & Engr—Oct. 29, 1904. No. 65872.

Transformer Iron.

The Testing of Transformer Iron. Lancelot W. Wild. Remarks on the wattmeter method of testing transformer iron, describing the apparatus used at the Westminster Electrical Testing Laboratory. 1600 w. Elect'n, Lond—Nov. 11, 1904. No. 66195 A.

Wattless Current.

A Protest on Behalf of Wattless Current. E. J. Willis. A discussion of the theory of alternating currents with diagrams showing how the expression for their energy should be regarded. 2400 w. Stevens Ind—Oct., 1904. No. 66406 D.

GENERATING STATIONS.

Cheltenham.

Cheltenham Electrical Undertaking. Full text of the report of James Swinburne on the municipal plant at Cheltenham, England, with editorial comment. 7200 w. Elec Engr, Lond—Nov. 18, 1904. No. 66381 A.

Dynamos.

The Unipolar Dynamo. Abstract translation of a paper by J. Seidener, in the *Zeitschrift für Elektrotechnik*. An illustrated discussion of these machines, and especially with reference to their combination with steam turbines. 1300 w. Elec Rev, Lond—Nov. 18, 1904. No. 66382 A.

The Unipolar Dynamo (Die Unipolarmaschine). J. Seidener. Describing a double-disc single-pole dynamo adapted for high rotative speeds, and hence for direct connection to steam turbines. 2500 w. Zeitschr f Elektrotechnik—Oct. 23, 1904. No. 66245 D.

Generating Set.

Electric Generating Set by the Delaunay-Belleville and Eclairage Electrique Companies (Groupe Electrogène des Sociétés Delaunay-Belleville et l'Eclairage Electrique). Ch. Dantin. Illustrating the 1500 h. p. quadruple-expansion engine, and Labour alternator exhibited at St. Louis. 1500 w. 1 plate. Génie Civil—Oct. 29, 1904. No. 66214 D.

Hydro-Electric.

Chaux-de-Fonds — Lode Hydraulic Plant. C. L. Durand. Illustrated description of a Swiss plant using the high-potential direct-current system, with generators and motors in series. 3200 w. Elec Rev, N. Y.—Nov. 5, 1904. No. 65936.

Extension of Dam and Paving of River Bank at Des Moines, Ia. C. B. Burdick. Illustrates and describes the hydraulic plant of the Des Moines Edison Light Co., and the improvements recently made. 1500 w. Eng News—Nov. 17, 1904. No. 66129.

The Highest Fall in the World. Enrico Bignami. Illustrated description of the hydroelectric station in the Valais Canton, Switzerland, utilizing a head of 3,116 feet. 2800 w. Elec Rev, N. Y.—Oct. 29, 1904. No. 65867.

Isolated Plant.

The Power Plant of the "Glass Block," Minneapolis. Illustrates and describes a plant designed to supply heat, light, power and water to a large department store. 3000 w. Elec Rev, N. Y.—Nov. 26, 1904. No. 66340.

Manchester.

The Stalybridge, Hyde, Mossley, and Dukinfield Tramways and Electricity Board's Scheme. An illustrated article giving information of recent work in the development of this scheme in the neighborhood of Manchester, Eng. 3000 w. Elec Rev, Lond—Nov. 11, 1904. No. 66194 A.

Power Plants.

An Economical Power Plant at Lima, Ohio. Frank D. Rae. An illustrated description of a plant embracing the latest ideas of equipment in connection with reciprocating engines, and introducing a novel floor arrangement of apparatus. 5500 w. St Ry Jour—Nov. 26, 1904. No. 66370 C.

A Notable Electric Power Station. An illustrated article describing the plant of the St. Lawrence River Power Company at Massena, New York. 1800 w. Stevens Ind—Oct., 1904. No. 66402 D.

Power Plant of the Railway Exchange Building, Chicago. Illustrated description of a plant possessing some novel features necessitated by the somewhat unusual conditions under which it is operated. 2500 w. Engr, U S A—Nov. 15, 1904. No. 66059 C.

The Power Plant of the Lewis Publishing Company, St. Louis, and the Largest Searchlight in the World. Illustrates and describes a plant having many interesting features seldom encountered. 1500 w. Elec Wld & Engr—Nov. 12, 1904. No. 66033.

The Power Plant of the Tall Office Building. S. H. Bunnell. A comparison between compound and four-valve simple engines running non-condensing. 1500 w. Trans Am Soc of Mech Engrs, No. 045—Dec., 1904. No. 66074.

Storage Batteries.

Some Notes on the Edison Nickel-Iron Storage Battery. F. M. Davis. A report of tests made and the results of the investigation. General discussion. 12000 w. Jour W Soc of Engrs—Oct., 1904. No. 66098 D.

The Care of Storage Batteries. John Howatt. Gives suggestions for the proper care of a battery plant. 1400 w. Power—Nov., 1904. No. 65877 C.

Switchboards.

Modern High-Potential Switchboard Practice. Bertrand Perry Rowe. An illustrated description of modern switchboard practice, especially in connection with high-tension work. 2500 w. Elec Rev, N. Y.—Oct. 29, 1904. Serial. 1st part. No. 65866.

Switchboard Design. A. S. Loizeaux. Illustrates and describes some of the most distinct types, giving the purposes for which they are used; also their general layout and equipment. 2500 w. Stevens Ind—Oct., 1904. No. 66408 D.

Transformers.

The Graphic Treatment of the Phenomena of Static Transformers and Induction Motors. A. S. McAllister. An outline description presenting the facts upon which the construction of the circular diagram depends and giving a comprehensive example of its application to an induction motor treated as a transformer. 3000 w. Sib Jour of Engng—Nov., 1904. No. 66086 C.

Turbine Generator.

See Mechanical Engineering, Steam Engineering.

LIGHTING.

Decorations.

The Electrical Decorations of San Francisco. Illustrates and describes the more prominent illuminations, giving details of difficulties encountered and the means of overcoming them. 1500 w. Jour of Elec—Nov., 1904. Serial. 1st part. No. 65957 C.

Electric Signs.

"Signs of the Times." E. Leavenworth Elliott. Discusses the various uses of electric signs and the methods and principles involved in their construction. 2800 w. Cent Sta—Nov., 1904. No. 66014.

Nernst Lamp.

The Nernst Lamp as a Factor in Commercial Lighting. E. R. Roberts. Reviews the history of this form of electric lighting, its development in America, its efficiency, applications and progress. 4200 w. Cent Sta—Nov., 1904. No. 66015.

Theatres.

Electricity in Stage Lighting (Die Elektrizität im Bühnenwesen). Heinrich Rupprecht. Describing lamps, projectors and general systems of wiring in the use of electric lighting for theatres. Two articles. 4000 w. Elektrotech u Polytech Rundschau—Nov. 1, 15, 1904. No. 66281 each B.

MEASUREMENT.

Curves.

Graphic Tracings of the Faradic and Other Interrupted Currents. H. Lewis Jones. Gives results of examination of the characteristic curves of certain medical induction coils. 3400 w. Elec Rev, N. Y.—Nov. 26, 1904. No. 66342.

Electrode-Potential.

The Measurement of the Potential of the Electrodes in Stationery Liquids. Henry J. S. Sands. Read before the Faraday Society. Describes a method which will allow the electrode potential in stationary liquids of the most varying kind to be measured, when much larger currents are employed than those which can be made use of according to Cottrell's method, and indicates conclusions drawn. Ills. 3700 w. Elect'n, Lond—Oct. 28, 1904. Serial. 1st part. No. 65981 A.

Resistance Boxes.

Resistance Boxes for Use in Precise Alternating Current Measurements. George A. Campbell. Shows that a practically reactanceless coil may be produced by double-winding the coil as usual and then shunting the coil with a definite small condenser. 1700 w. Elec Wld & Engr—Oct. 29, 1904. No. 65871.

Voltmeters.

Alternating-Current Compensated Voltmeters. H. W. Young. Considers the more important types of a device by the use of which the pressure maintained at the point of distribution can readily be determined and the potential regulators properly adjusted to maintain the desired voltage. 2000 w. Am Elect'n—Nov., 1904. No. 65910.

Wattmeters.

The Care, Testing and Adjustment of Integrating Wattmeters. K. L. Aitken. Information of a general nature. 1700 w. Can Elec News—Nov., 1904. No. 66120.

MOTORS.

Alternating Motors.

The Theory of the Winter-Eichberg Motor (Zur Theorie des Winter-Eichberg-Motors). Paul Müller. A comparison of the Winter-Eichberg motor with the single-phase induction motor, deriving diagrams and formulas for the former. 6500 w. Elektrotech Zeitschr—Oct. 27, 1904. No. 66238 B.

Control.

Multiple-Voltage Control of Motors. Norman Gardner Meade. Gives an outline of the multiple-voltage system and the methods of control employed, and its application to machine tool operation. Ills. 2400 w. Power—Nov., 1904. No. 65875 C.

Design.

The Rational Design of Asynchronous Motors (Sur l'Etablissement Rationnel des Moteurs Asynchrones). C. F. Guilbert. Working out the mathematical computations for the proportions giving the maximum efficiency. 1500 w. Revue Technique—Oct. 25, 1904. No. 66220 D.

Diagrams.

The Alternating-Current Series Motor Considered as a Choking Coil (Der Wechselstrom-Serienmotor als Allgemeine Drosselspule). H. Weichsel. Study of the circle diagram, showing the identity of the diagrams of the alternating series motor and the ordinary choking coil. 2500 w. Elektrotech Zeitschr—Oct. 20, 1904. No. 66237 B.

Induction Motors.

The Induction Motor with High Resistance Secondary. C. J. Spencer. Defines certain cases where the installation of such a type of motor is desirable. 1100 w. Elec Wld & Engr—Nov. 26, 1904. No. 66375.

Polyphase.

Some Polyphase Motors (Ausgeführte Drehstrommotoren). Jens Bache-Wiig. Describing motors of 250, 25, and 0.25 horse power, of simple construction and high efficiency. 2500 w. Zeitschr f Elektrotechnik—Nov. 6, 1904. No. 66247 D.

Repulsion Motor.

The Second Form of Repulsion Motor and the Compensated Series Motor (Die Zweite Form des Repulsionsmotors und des Kompensierten Reihenmotors). M. Latour. With diagrams showing the various modifications in the commutation. 1200 w. Elektrotech Zeitschr—Nov. 10, 1904. No. 66242 B.

Single Phase.

Paper on Single-Phase Railway Motors at the New York Electrical Society. Lecture by Prof. A. S. McAllister in abstract, with remarks by Frank J. Sprague. 3700 w. St Ry Jour—Nov. 12, 1904. No. 66024 C.

Railway Motors for Single-Phase Alternating Current. Dr. Hans Behn-Eschenburg. Illustrates and describes two of the later single-phase commutator types of motor made by the Oerlikon Company, criticizing their characteristics as deduced from experimental results. 2600 w. Engng—Nov. 4, 1904. No. 66052 A.

Single-Phase Commutator Motors. Seijiro Sugiyama. A theoretical treatment of series and repulsion motors. Mathematical. 700 w. Elec Wld & Engr—Oct. 20, 1904. Serial. 1st part. No. 65870.

See also Street and Electric Railways.

TRANSMISSION.

Austria-Hungary.

The Electrical Equipment of the Karawanken Tunnel. Illustrated description of an interesting power transmission plant and equipment in Austria-Hungary for transmitting power to be used in tunnel construction. 1300 w. Elec Wld & Engr—Nov. 12, 1904. No. 66032.

High Tension.

Some Operating Experiences in High-Tension Transmission. D. L. Huntington. Read before the Assn. of Edison Illuminating Cos. at Newcastle, N. H. An account of operating experiences with reference to unexpected problems, and methods of solving them, at Boston. 4000 w. Elec Rev, N. Y.—Oct. 29, 1904. No. 65869.

Long Distance.

Economics of a 200-Mile Transmission. J. Eugene Wallace. An explanation of rules and formulas resulting from a study of the methods of calculating voltages and line efficiencies, illustrating by an assumed enterprise. 1500 w. Elec Wld & Engr—Nov. 5, 1904. No. 65956.

Review.

Electrical Power-Generating Stations and Transmission. L. B. Stillwell. Read before the Int. Engng. Cong., St. Louis. A review of the changes that have occurred during the last ten years, the progress in transmission, &c. 7000 w. Elec Rev, N. Y.—Oct. 29, 1904. No. 65868.

Safety Appliance.

A Safety Appliance for High Tension Electric Conductors (Sur un Dispositif de Securité pour Canalisations Electriques à Haute Tension). L. Neu. Describing a safety switch arranged to cut off the current in case of defective insulation or accidental contact. 1000 w. Comptes Rendus—Oct. 31, 1904. No. 66233 D.

MISCELLANY.

Address.

Dr. Siemens' Presidential Address to the Institution of Electrical Engineers. Discusses the relations between capital and labor and the management of works. 6700 w. Elect'n. Lond—Nov. 11, 1904. No. 66196 A.

INDUSTRIAL ECONOMY

Coal Mining.

The Coal Mine Operator versus the Public. Herman Justi. An address on "Coal Men's Day" at the Louisiana Purchase Exposition, St. Louis. Considers the peculiar conditions which have resulted in criticism of operators by the general public. 8000 w. Mines & Min—Nov., 1904. No. 65935 C.

Cost-Finding.

Economy in Foundry Cost-Finding. Jas. C. Loughry. Read at the A. F. A. Convention, June, 1904. A brief explanation of a ledger balance system and the results obtained, with remarks. 3400 w. Foundry—Nov., 1904. No. 65888.

Education.

Contemporary Technical Education. John R. Freeman. An address at the "Case School of Applied Science." Remarks on technical graduates and their opportunities, with notes of interest. 6000 w. Jour W Soc of Engrs—Oct., 1904. No. 66097 D.

Iron Industry.

Changes in the American Iron Industry

Since the Iron and Steel Institute Meeting of 1890. B. E. V. Luty. Briefly reviews the more important changes that have occurred during fourteen years. 4500 w. Ir Trd Rev—Oct. 27, 1904. No. 65861.

Organization.

The Office Organization. W. R. Heath. A discussion of the principles upon which business is based. 5000 w. Cent Ry Club—Nov. 11, 1904. No. 66069 C.

Shipping.

The World's Ocean-Going Trade. Bryson Cunningham. An examination of the shipping statistics, with especial reference to British shipping and a comparison of other nations. Ill. 3000 w. Cassier's Mag—Nov., 1904. No. 66061 B.

Works Management.

System in Manufacturing Establishments. E. R. Douglas. An explanation of modern methods of maintaining economy in manufacturing works, the careful looking after details, &c. 7500 w. Stevens Ind—Oct., 1904. No. 66403 D.

MARINE AND NAVAL ENGINEERING

Battleships.

H. M. S. King Edward VII. Illustration, with brief description. 800 w. Engr, Lond—Nov. 4, 1904. No. 66055 A.

Steam Trials of H. M. S. "Dominion." Illustrations, description, and report of trials. 1400 w. Engng—Nov. 4, 1904. No. 66051 A.

The Sea-Going Battleship. Commander William Hovgaard. An attempt on basis of general principles, to arrive at the type and size of warship best suited to secure command of the ocean. Ills. 11000 w. Soc Naval Archts & Marine Engrs, No. 3—Nov., 1904. No. 66137 D.

Boilers.

See Mechanical Engineering, Steam Engineering.

Capstan.

Improved Electric Capstan (Nouveau Système de Cabestan Electrique). F. Loppé. Describing the electric capstan made by the Creil Works; so arranged that it can be inverted upon trunnions to give access to the electric machinery. 1800 w. Revue Technique—Oct. 25, 1904. No. 66219 D.

Coaling.

Coaling Warships at Sea—Recent Developments. Spencer Miller. An illustrated article reviewing the development from 1900 to the present time. 9500 w. Soc of Naval Archts & Marine Engrs, No. 7—Nov., 1904. No. 66141 D.

Coast Defense.

The Semi-Globular Naval Battery. Anson Phleps Stokes. An illustrated explanation of the designs for a vessel invented by the writer. It is considered an impregnable coast defense ship, and a powerful battleship. 4800 w. Soc of Naval Archts & Marine Engrs, No. 2—Nov., 1904. No. 66136 D.

Cruisers.

H. M. Armored Cruiser Black Prince. Detailed description. 1800 w. Engr, Lond—Nov. 11, 1904. No. 66304 A.

The Japanese Cruisers Nisshin and Kasuga. Illustrations, with description. 1500 w. Engr, Lond—Nov. 4, 1904. No. 66057 A.

The U. S. Armored Cruiser Colorado. J. M. Powell. An illustrated description of this vessel and its performance. 5500 w. Soc of Naval Archts & Marine Engrs, No. 17—Nov., 1904. No. 66151 D.

Cylinders.

The Breakage and Renewal of a Large Cylinder. Hector MacColl. An account of a cylinder broken at sea, the work of renewal, and the lessons learned from the occurrence. Plate. 1200 w. Trans Inst of Engrs & Shipbuilders of Scotland—Oct. 25, 1904. No. 66412 D.

Dry Docks.

See Civil Engineering, Waterways and Harbors.

Ferryboats.

Ferry Transportation. Capt. J. M. Cherry. An illustrated review of the old and the modern methods of handling passengers in and around New York. Also gives briefly an account of the ferry service at San Francisco. Discussion. 16000 w. Pro N Y R R Club—Oct. 21, 1904. No. 66107.

Fuel Endurance.

Speed and Consumption of Steamships. J. F. Ruthven. Suggestions on the importance of understanding how to vary the speed so as to get the best value out of the coal. 3000 w. Jour Roy United Serv Inst—Oct., 1904. No. 65887 E.

Great Britain.

Naval Architecture. Sir William H. White. Read before the Int. Engng. Cong. at St. Louis. Indicates the principal advances made in methods of ship construction and propulsion during the last ten years in Great Britain. 6000 w. Marine

Engng—Nov., 1904. Serial. 1st part. No. 65853 C.

Launching.

Recent Launching Practice of the Atlantic Coast. R. H. M. Robinson. Gives launching data, with description of special features in the methods used on the Connecticut, recently launched. 1400 w. Soc of Naval Archts & Marine Engrs, No. 14—Nov., 1904. No. 66148 D.

Recent Launching Practice of the Pacific Coast. Everett P. Lesley. Illustrates and describes features of interest in the recent launching of the U. S. S. California, South Dakota, and Milwaukee. 1700 w. Soc of Naval Archts & Marine Engrs, No. 15—Nov., 1904. No. 66149 D.

Machinery.

Maintenance of Machinery in Merchant Ships. Robert Haig. Discusses this subject, considering the various changes, improvements and developments that experience gained in maintenance has brought about. 12000 w. Soc of Naval Archts & Marine Engrs, No. 11—Nov., 1904. No. 66145 D.

Marine Engines.

Marine Engine Models at South Kensington. Brief descriptions of interesting models on exhibition in England. 2400 w. Engr, Lond—Nov. 18, 1904. No. 66394 A.

Motor Boats.

High Speed Gasoline Launches. Clinton H. Crane. Illustrated description of the performance of the Vingt-et un II, and information of general interest. 1700 w. Soc of Naval Archts & Marine Engrs, No. 12—Nov., 1904. No. 66146 D.

Speed and Power of Recent Motor Boats of Several Types. Alpheus A. Packard. Illustrates and describes various types of boats, giving actual results as to speed and power. 2500 w. Soc of Naval Archts & Marine Engrs, No. 13—Nov., 1904. No. 66147 D.

Navigation.

A Geometric Solution of the Problem of Great-Circle Sailing (Soluzione Geometrica del Problema della Navigazione per Cerchio Massimo). Prof. Luigi Masnata. Developing graphical methods for determining a number of points on the arc of a great circle. 5000 w. Rivista Marittima—Oct., 1904. No. 66252 H.

Paddle Steamer.

Paddle Steamer for the Anatolian Railway Company of Constantinople (Passagier-Raddampfer für die Anatolische Eisenbahn-Gesellschaft in Konstantinopel). Description and illustrations of the passenger steamer Basra built at the Howaldts Works at Kiel. 1800 w. Schiffbau—Nov. 9, 1904. No. 66273 D.

Progress.

Developments in Means of Communication by Sea During the Nineteenth Century. Dr. Robert-Caird's lecture under the auspices of the Royal Philosophical Society of Glasgow. A review of the period from 1802 till 1902. 3500 w. Sci Am Sup—Nov. 19, 1904. Serial. 1st part. No. 66117.

Propellers.

Tests of Various Types of Propellers (Proeven met Schroeven van Verschillend Type). Murk Lels, Jr. With curves plotted from tests of screw propellers with blades bent back at various angles. 1200 w. De Ingenieur—Sept. 17, 1904. No. 66275 D.

Propulsion.

Triple Screw Propulsion. Rear-Admiral George W. Melville. Gives reasons in favor of the three-screw system, and also some of the disadvantages that might arise. 3600 w. Marine Engng—Nov., 1904. No. 65851 C.

Repairs.

Interesting Repair Work on the Steamship "Ekliptika." Dr. Alfred Gradenwitz. An illustrated article describing the raising and repairing of a vessel wrecked on the Swedish coast. 800 w. Sci Am Sup—Nov. 26, 1904. No. 66309.

The Repairing of the Steamship Ekliptika (Die Reparatur des Dampfers Ekliptika). An account of the raising and docking of a vessel after being submerged for more than a year off the coast of Sweden. 1000 w. Schiffbau—Sept. 14, 1904. No. 66267 D.

Report.

Steam Engineering in the Navy. Advance abstract of the annual report of Chief Engineer Rae, outlining important plans for experimental work of interest to engineers and builders of ships and engines. 1000 w. Ir Age—Nov. 17, 1904. No. 66109.

Resistance.

The Theory of Froude's Constant for the Determination of Ship's Resistance (Beitrag zur Theorie der Konstanten Froude's zur Bestimmung des Schiffswiderstandes). A mathematical examination of the derivation of Froude's Constant. 1800 w. Schiffbau—Oct. 26, 1904. No. 66272 D.

Sanitarium.

A Design for a Floating Sanitarium (Entwurf zu einem Schiffssanatorium). Oswald Flamm. Complete designs for a ship intended to serve as a sanitarium at sea for such patients as would be benefitted by sea air. 2000 w. 3 plates. Schiffbau—Oct. 12, 1904. No. 66269 D.

Special Machinery.

Special Machinery and Appliances on Board Ship. George McQuilkin, Jr. Shows the important bearing electrical installations have had on the development of special machinery. 2400 w. Marine Rev—Nov. 3, 1904. No. 65959.

Special Machinery on Board a Naval Ship. Perry K. Thurston. Describes some of the conveniences and labor-saving devices used on the modern naval vessel. 2800 w. Marine Rev—Nov. 3, 1904. No. 65960.

Stability.

A New Interpretation of Experiments upon the Stability of Ships (Sopra una Nuova Interpretazione della Esperienza di Stabilita delle Navi). A. Scribanti. Deriving new equations for the curve of stability for use with experimental data. 6000 w. Rivista Marittima—Aug.-Sept., 1904. No. 66251 H.

On the Determination of the Vertical Position of the Center of Gravity of a Ship by Means of a Dock Trial. Translated from *Schiffbau.* Describes a purely theoretical method, not yet put in practice. 1200 w. Prac Engr—Nov. 11, 1904. No. 66191 A.

The Determination of the Position of the Centre of Gravity by Dock Trials (Bestimmung der Höhenlage des Systemsschwerpunktes durch einen Dockversuch). Alexander Dietzius. The height of the centre of gravity is determined by observing the depth of water in the dock at the moment when the stability becomes zero. 1200 w. Schiffbau—Sept. 28, 1904. No. 66268 D.

The Position of the Center of Lateral Resistance. L. E. Bertin. Considers the point of application of all the forces tending to resist the lateral motion of a vessel, discussing its experimental determination. 800 w. Soc of Naval Archts & Marine Engrs, No. 5—Nov., 1904. No. 66139 D.

Steamships.

Mammoth Steamship Dakota. Large illustration with description of this vessel, its equipment and pumping machinery. 4000 w. Am Shipbuilder—Nov. 24, 1904. No. 66391.

Steam Turbines.

The Economy of Steam Turbines in Cruisers. Ediorial on the trials of H. M. S. Amethyst, which demonstrated the economy of the Parsons steam-turbine. 4000 w. Engng—Nov. 18, 1904. No. 66389 A.

Submarines.

The Evolution of the Submarine and How Far the Lake Type Solves the Problem. Robert G. Skerrett. Discusses types, and methods of submergence, and reviews the development of the Lake type. Ills. 10900 w. Jour U S Art—Sept., 1904. No. 65903 D.

Tank Trials.

Some Recent Experiments at the U. S. Model Basin. D. W. Taylor. An account of experiments, the primary object being the determination of the power and efficiency of model propellers of the ordinary three-bladed type throughout the range of pitch ratio and blade area likely to be encountered in practice. Ills. and diagrams. 4500 w. Soc of Naval Archts & Marine Engrs, No. 6—Nov., 1904. No. 66140 D.

Torpedo Vessels.

Some Further Notes on the Performance of the Torpedo Vessels of the United States Navy at Sea. Lieut. L. H. Chandler. Tabulated information, illustrations and remarks of interest. 6000 w. Soc Nav Archts & Marine Engrs, No. 4—Nov., 1904. No. 66138 D.

Turbine Propulsion.

Design for a Light Draught Double Turbine Boat (Entwurf eines Flachgehenden Zwei-Turbinenschrauben-Bootes). O. Lienau. Plans and details of a flat-bottomed light-draught steamboat with turbine propellers, for river inspection service. Two articles. 4000 w. Schiffbau—Oct. 26, Nov. 9, 1904. No. 66271 each D.

Ventilation.

Some Experiments with Ventilating Fans. D. W. Taylor. An account of experiments made for supplying fresh air to vessels, to determine the fan that will supply the required quantity of air with the least expenditure of power. 4500 w. Eng News—Nov. 3, 1904. No. 65922.

Warships.

Simple Methods in Warship Design a Necessity. George W. Dickie. A discussion of the importance of this subject, presenting plans showing the application of methods proposed to secure the results aimed at in a modern armored cruiser. 11200 w. Soc of Naval Archts & Marine Engrs, No. 1—Nov., 1904. No. 66135 D.

Warships of the Great Powers. Archibald S. Hurd. A study of relative costs. 5800 w. Cassier's Mag—Nov., 1904. No. 66064 B.

Weights.

Subdivision of Weights in Ships' Displacement. Nabor Soliani. Aims to induce some step to be taken toward the avoidance of the vagueness in relation to the distribution of the weights of various parts of a vessel. 4500 w. Soc of Naval Archts & Marine Engrs, No. 10—Nov., 1904. No. 66144 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Darracq.

The 15-H. P. Darracq. Illustrated description of the latest pattern Darracq car. 1200 w. Autocar—Nov. 5, 1904. No. 66042 A.

De Dion.

The 15-H. P. 4-Cylinder De Dion Car. An illustrated detailed description of a new model. 1100 w. Auto Jour—Nov. 12, 1904. Serial. 1st part. No. 66186 A.

Electric Transmission.

Electric Transmission Devices for Automobiles: the Jeantaud and the Electrogenia Systems. Illustrates and describes two new devices recently brought out in Paris. 1500 w. Sci Am Sup—Nov. 26, 1904. No. 66311.

Gasoline.

Adams-Farwell Car with Rotating Motor. Illustrates and describes details of interest in a new gasoline automobile. 1100 w. Automobile—Oct. 29, 1904. No. 65850.

Hotchkiss.

The Hotchkiss Cars. Illustrates and describes interesting details of these cars. 1800 w. Autocar—Oct. 29, 1904. No. 65973 A.

Hutton.

The Hutton 4-Cylinder Light Car. Illustrated description. 2500 w. Auto Jour —Nov. 5, 1904. No. 66041 A.

Igniter.

The Bullock Igniter. Description and diagrams showing the method of employing the electric current for the ignition of the compressed charges of carburetted air within the cylinders of explosion motors. 900 w. Autocar—Nov. 12, 1904. No. 66189 A.

Motor Mail.

A Night with the Royal Motor Mail. R. G. Wells. An illustrated account of the Manchester-Liverpool motor mail service. 1500 w. Autocar—Nov. 12, 1904. No. 66188 A.

"Rational."

The 10-H. P. "Rational" Petrol Car. Begins an illustrated detailed description of this car. 1200 w. Auto Jour—Nov. 19, 1904. Serial. 1st part. No. 66352 A.

Seabury.

Seabury 24-H. P. Gasoline Automobile. Describes a touring-car being built at the Morris Heights shops. 2200 w. Automobile—Nov. 26, 1904. No. 66336.

Speed Records.

Recent Automobile and Motor-Boat Speed Records. A review of the speeds attained during the last racing season. Ills. 1200 w. Sci Am—Nov. 19, 1904. No. 66113.

Storage Batteries.

See Electrical Engineering, Generating Stations.

Timing.

A Mors Electric Device for Timing Automobiles. B. F. Hirshaur. Illustrated description of a new electric chronometer. 2200 w. Elec Rev, N. Y.—Nov. 26, 1904. No. 66341.

Vauxhall.

The Three-cylinder Vauxhall Car. Begins an illustrated detailed description of this new car. 1500 w. Autocar—Nov. 12, 1904. Serial. 1st part. No. 66187 A.

Winton.

The Winton Petrol Cars. An illustrated description of the leading characteristics of the 20 h. p. model. 2000 w Auto Jour—Oct. 29, 1904. Serial. 1st part. No. 65972 A.

HEATING AND COOLING.

Freezing.

The Danger of Freezing in Hot-Water and Low-Pressure Heating Systems (Die Einfriergefahr bei Niederdruckdampf- und Warmwasserheizung). W. Schweer. Describing precautions to be taken to prevent injury to pipes and radiators in cold weather. 2500 w. Gesundheits-Ingenieur —Oct. 31, 1904. No. 66264 B.

Hospital.

The Heating System of the Johannstadt Hospital, Dresden-Altstadt (Die Heizanlagen im Krankenhaus Johannstadt, Dresden-Altstadt). Erwin Nicolaus. Describing a central heating plant using hot water for a large hospital in Dresden. 4000 w. 2 plates. Gesundheits-Ingenieur — Oct. 10, 1904. No. 66263 B.

Kryptol.

Kryptol, a New Substance for Electric Heating. Information concerning an indirect electrical heating system recently invented in Germany. Ills. 1200 w. U S Cons Repts—Oct., 1904. No. 66369 D.

Ventilation.

Ventilation. W. Henman. Read before the Archt. Assn., England. Paper and discussion on modern practice in ventilating buildings. 11600 w. Builder—Nov. 19, 1904. No. 66350 A.

HYDRAULICS.

Air-Lift.

An Ingenious and Effective Air-Lift Pump. Illustration, with description, of pump invented by D. W. Starrett. 1500 w. Eng News—Nov. 24, 1904. No. 66335.

Hydraulic Rams.

Note on Action of Hydraulic Rams. A. J. Wood. Gives diagrams obtained in a test, typical for the pressure shown, with explanation of the action. 500 w. Stevens Ind—Oct., 1904. No. 66405 D.

Hydraulic Tools.

Hydraulic Punching and Shearing Machinery (Lochstanze und Blechschere mit Druckwasserbetrieb). A. Heller. Illustrating tools operated by water at a pressure 120 to 150 atmospheres, and used for punching plates up to 35 mm. thick. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 5, 1904. No. 66209 D.

Hydroelectric Stations.

See Elecerical Engineering, Generating Stations.

Jet Pump.

The Jet Pump as an Hydraulic Apparatus. F. G. Hesse. Considers the jet pump as an hydraulic apparatus in which the jet and the liquid to be raised are both non-compressible and of the same density. 1000 w. Jour Assn of Engng Socs—Sept., 1904. No. 66171 C.

Plumbing.

Modern Plumbing. R. M. Starbuck. A practical review of the requirements of good plumbing. Ills. 2000 w. Archts & Bldrs Mag—Nov., 1904. Serial. 1st part. No. 65953 C.

Presses.

British Hydraulic Machinery. A. F. Petch. An illustrated account of various special hydraulic presses used in the manufacture of munitions of war. 3000 w. Cassier's Mag—Nov., 1904. No. 66062 B.

Design of a 4,000-Ton Hydraulic Press. W. E. Morey. Illustrates and describes the designing of a press to meet stated requirements. 1600 w. Am Mach—Nov. 17, 1904. Serial. 1st part. No. 66111.

Hydraulic Forging Presses. Illustrates and describes a new 3,000-ton hydraulic press. 2200 w. Engng—Nov. 11, 1904. No. 66198 A.

Pumping Plant.

Pumping Plant at Chatham Dock-Yard. Illustrates and describes two sets of high-duty pumping engines and their operation. 600 w. Engr, Lond—Nov. 18, 1904. No. 66396 A.

The Pumping Plant of the Utrecht Water Works (De Pompwerktuigen van de Utrechtsche Waterleiding). J. C. Dijxhoorn. Details of the performance of simple and compound engines, by Carels, of Ghent, and Sulzer, of Winterthur, with steam and water indicator diagrams. 3000 w. De Ingenieur—Sept. 17, 1904. No. 66276 D.

Pumps.

Pumps in Central Stations. W. T. Edwards. Discusses the importance of the pump as a factor in the economical operation of a power plant. 2200 w. Am Elect'n—Nov., 1904. No. 65912.

Standpipes.

A New Hydraulic Experiment. A. F. Nagle. Experimental investigation of the rise of water in a standpipe having a long supply pipe, when the draft suddenly ceases. Ills. 1200 w. Trans Am Soc of Mech Engrs, No. 050—Dec., 1904. No. 66103.

Steam Pumps.

Tables for Computing Compound Duplex Steam Pumps. C. J. Mitchell. Gives tables useful in determining the principal proportions of these pumps, illustrating the method of using them. 1500 w. Eng News—Nov. 17, 1904. No. 66128.

The Time Required to Raise Steam for Fire Pumps from Cold Boilers and the Cost of Banked Fires. Gives conclusions drawn from tests made by inspectors of the Associated Factory Mutual Fire Insurance Co., at Fall River, Mass., to determine whether it would be safe for the mills to allow the fire to be drawn from their fire-pump boilers during a shutdown. 1500 w. Eng News—Nov. 3, 1904. No. 65924.

Turbine Pumps.

Turbine Pumps in Irrigation. J. J. Brown. From an address before the Nat. Ir. Cong. at El Paso, Tex. General remarks on land developed by the pumping system, especially discussing the advantages of the centrifugal pump. 3300 w. Mfrs Rec—Nov. 24, 1904. No. 66312.

Water Power.

Some Details Entering into the Computation of the Values of Water Powers, and the Damages Caused by the Diversion of Water Used for Power. Charles T. Main. Considers the methods of determining the value, and the damages, the flow, &c. 6500 w. Trans Am Soc of Mech Engrs, No. 025—Dec., 1904. No. 66076 C.

Water-Wheels.

The Governing of Impulse Water-Wheels. John Goodman. Deals chiefly with impulse water-wheels in which the whole energy of the water is converted into kitetic energy before it impinges on the vanes of the motor; such motors are tangent wheels, Pelton wheels, action or impulse turbines. 1700 w. Engng—Nov. 4, 1904. No. 66050 A.

INTERNAL-COMBUSTION MOTORS.

Combustion Chamber.

Experiments with a Chamber for the Production of a Hot Working Fluid to be Used in the Generation of Power. J. F. Wentworth. Describes investigations extending through six months on a working fluid for internal combustion engines. 3000 w. Power—Nov., 1904. No. 65878 C.

Diesel.

The Diesel Engine. A. W. Oppenheimer. Describes and illustrates the Diesel engine, explaining the principles upon which it is based, its operation, &c. 3300 w. Sci Am Sup—Nov. 5, 1904. No. 65927.

The Diesel Engine in Practice. James D. Macpherson. Describes this form of internal combustion engine as used in America; the operation, types, regulation, &c. Discussion. 2700 w. Pro Engrs' Club of Phila—Oct., 1904. No. 66068 D.

Gas Engines.

Gas Engine Power Plants. Irving A. Chandler. Presents the qualifications which make the gas engine power plant particularly suitable for mining purposes. Ills. 2500 w. Min Mag—Oct., 1904. No. 66085 C.

Gas Engine Testing at the Works of the Westinghouse Machine Co. A brief explanation of the gas engine tests as made at these shops. 900 w. Eng Rec—Nov. 19, 1904. No. 66156.

Gasoline Motor.

The Adams Farwell Gasoline Motor. Illustrated description of an engine designed for automobile use in which the engine shaft remains stationary and the cylinders revolve around it. 2400 w. Ir Age—Nov. 3, 1904. No. 65906.

Gas Turbines.

A Scientific Investigation into the Possibilities of Gas Turbines. R. M. Neilson. Compares the advantages and possibilities of gas turbines worked on different cycles, and the difficulties to be overcome to make these turbines a success. 12700 w. Inst of Mech Engrs—Oct. 21, 1904. No. 65885 D.

Heat Engines.

A Proposed Modification of the Perfect Heat-Engine Formula. Louis Illmer, Jr. Suggestions regarding the improvement of the isolation factor indicating the lines along which increase in the economy of internal combustion motors is to be sought. 6000 w. Jour Fr Inst—Nov., 1904. No. 66093 D.

Heat Wastes.

Some Forms of Vapor Heat Maps with Vapor Table and Curves for Ether ($C_4H_{10}O$). Thomas M. Gardner. A discussion of the conditions under which the vapor of ether may be used in binary-vapor engines. 2500 w. Sib Jour of Engng—Nov., 1904. No. 66088 C.

Power Gas.

Power Gas (Kraftgas). Ferd. Fischer. A comparison of the various forms of fuel gas and their monetary values for the production of power. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1904. No. 66207 D.

MACHINE WORKS AND FOUNDRIES.

Boring.

A Worm Driven Auxiliary Table for a 16 by 24 Niles Boring Mill. H. G. Knoderer. Describes and illustrates the method used in the Westinghouse shops of extending a boring mill for large work. 700 w. Am Mach—Vol. 27, No. 45. No. 65993.

Boring Machine.

Boring Machine for Steam-Turbine Casings (Barrow's Patent) at Clydebank Shipyard. Illustrated description. 400 w. Engng—Nov. 11, 1904. No. 66301 A.

Castings.

On Small Plants for the Production of Castings. R. M. Daelen. Considers the working of small Bessemer plants, small open-hearth furnace, and the application of the electric current. 1500 w. Ir & Coal Trds Rev—Nov. 4, 1904. No. 66045 A.

Designing.

Things That Are Usually Wrong. John E. Sweet. The first of a series of articles commenting on faults overlooked by designers in making new machines or improving old ones. Ills. 700 w. Am Mach—Vol. 27, No. 45. No. 65994.

Dynamo Works.

The Lancashire Dynamo and Motor Company's Works. An illustrated detailed description of these shops and their development, and some of their products. 3500 w. Engr, Lond—Nov. 18, 1904. No. 66395 A.

Electric Driving.

Discussion on the Individual Operation of Machine Tools by Electric Motors. Discussion, with opening remarks by Charles Day. Ills. 9500 w. Jour Fr Inst—Nov., 1904. No. 66092 D.

The Electrical Equipment of a Modern Type Foundry. Illustrated description of the plant of the American Type Founders' Company, at Communipaw, N. J. 3300 w. Am Elect'n—Nov., 1904. No. 65908.

Fits.

Fits in Machine Construction (Die Passungen im Maschinenbau). Dr. G. Schlesinger. A discussion of the proper allowances to be made for running, driving, and forcing fits in machine work, with results of experiments. 3000 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1904. No. 66203 D.

Foundry.

An Up-to-Date Foundry and Electrical Plant. William D. Ranney and Robert N. Hemming. Brief illustrated description of the plant of the Buckeye Steel Casting Co. 1600 w. Engr, U S A—Nov. 1, 1904. No. 65890 C.

Foundry Practice.

Chemistry in the Foundry. Dr. R. Moldenke. Read before the New England Found. Assn. A discussion of this subject and the benefits derived, urging a careful study of the standard specifications for foundry pig iron. 2300 w. Ir Trd Rev—Nov. 17, 1904. No. 66122.

Foundry Practice with Copper and Its Alloys. W. J. Reardon. Read before the Electric Club. Describes the requirements, and the practice of making such castings at the Westinghouse foundry. 1200 w. Mech Engr—Oct. 29, 1904. No. 65975 A.

Lathes.

High-Speed Lathes. P. V. Vernon. An illustrated discussion of high-speed headstocks. 14300 w. Engr, Lond—Nov. 4, 1904. Supplement. No. 66058 A.

Machine Tools.

Machine Tools at the Parkhead Works. Illustrations, with brief descriptions, of three powerful machine tools recently installed in these Glasgow works. 1000 w. Engng—Nov. 18, 1904. No. 66386 A.

Milling.

Milling Cutters. Thomas R. Shaw. Illustrations, with descriptions, of various types of cutters. 3000 w. Mech Engr—Nov. 12, 1904. Serial. 1st part. No. 66192 A.

Molding.

Machine Molding a Special Gear—Fitting the Pattern. W. O. Smythe. Illustrates and describes the work. 2000 w. Am Mach—Vol. 27, No. 47. No. 66324.

Molding a Compound Gear on a Stripping Plate Machine. Illustrates and describes this method of molding. 2000 w. Am Mach—Vol. 27, No. 44. No. 65914.

Molding a Flywheel with Wrought-Iron Spokes. R. H. Palmer. Illustrates and describes the methods used in making a casting about 8 feet in diameter, weighing 5,000 pounds. 1000 w. Am Mach—Vol. 27, No. 45. No. 65992.

Molding Sheaves. Joseph Horner. Illustrated description of the method adopted. 1200 w. Am Mach—Vol. 27, No. 26. No. 66112.

The Molding of Double-Arm Pulleys (Das Formen einer Riemenscheibe mit Doppelten Armen). W. Emrich. Describing two methods of sweeping the rim and molding the arms. 1800 w. Stahl u Eisen—Oct. 15, 1904. No. 66255 D.

Sands.

Local Sands for Foundry Use. Walter J. May. Remarks on sands fit for foundry use, and their preparation. 900 w. Prac Engr—Nov. 11, 1904. No. 66190 A.

Shops.

Notes from the Jones & Lamson Shops. Brief illustrated descriptions of tools and methods used. 1800 w. Am Mach—Vol. 27, No. 47. No. 66323.

Tools.

Diamond Tools. G. C. Henning. A short illustrated description of these tools, used for cutting hard rubber, paper and hardened steel and also hard stone. 1400 w. Trans Am Soc of Mech Engrs, No. 052—Dec., 1904. No. 66101.

Tool System.

Systematization and Tool-Room Practice in a Railway Repair Shop. R. Emerson. The first paper discusses the extent to which standardization may be advantageously carried in a repair shop; together with the general organization of a tool management system. 3000 w. Engineering Magazine—Dec., 1904. No. 66288 B.

Tube-Mill.

The Operation of a Tube-Mlil. Hermann Fischer. Abstract from the *Zeitschrift des Vereines Deutscher Ingenieure*. Illustrated description of the operation of grinding. 2000 w. Eng & Min Jour—Nov. 17, 1904. No. 66126.

MATERIALS OF CONSTRUCTION.

Carborundum.

Carborundum. Dr. J. Ohly. Reviews the experiments of E. G. Acheson and the development of this substance, its uses, value, &c. 2000 w. Min Rept—Oct. 27, 1904. No. 65857.

Cast Iron.

Chemistry of Cast Iron. Herbert E. Field. Read before the New England Found. Assn. Discusses the composition and characteristics which make cast iron so valuable a product, the causes of the reactions, &c. 3000 w. Ir Trd Rev—Nov. 17, 1904. No. 66121.

Hardening.

The Le Chatelier Experiments on Hardening (Le Chatelier's Härteversuche). H. Haedicke. An account of the use of the Le Chatelier pyrometer for the measurement of temperatures during hardening processes. 2500 w. Stahl u Eisen—Nov. 1, 1904. No. 66258 D.

Hardness.

Indentation Tests on Steel. Illustrates and describes M. Guillery's apparatus and the method of making the tests. 1600 w. Engr, Lond—Oct. 28, 1904. No. 65985 A.

Impact Tests.

Impact Tests on the Wrought Steels of Commerce. A. E. Seaton and A. Jude. Aims to show some of the characteristics and peculiarities of wrought steel, to develop a more rational method of testing, and to point out peculiarities in the fracture of test specimens and actual pieces of machinery. 10 plates. 9300 w. Inst of Mech Engrs—Nov. 18 1904. No. 66392 D.

Metallography.

The Metallographic Department Technical School at Aix-la-Chapelle (Die Metallographische Einrichtung des Eisenhüttenmännischen Instituts in Aachen). A. Schüller. With illustrations of the micro-photographic apparatus, and a description of the methods of work. 2000 w. Stahl u Eisen—Oct. 15, 1904. No. 66253 D.

Solders.

Tests Made on Solders for Steel Brazing. Describes the tests and gives the results. 700 w. Engng—Oct. 28, 1904. No. 65983 A.

Steel.

The Transformation Temperatures of Steels (Sur les Températures de Transformation des Aciers). MM. G. Charpy and L. Grenet. Tabulated results of the determination of the temperatures by the measurement of the expansion, comparing these with the results of the thermo-electric method. 600 w. Comptes Rendus—Oct. 10, 1904. No. 66231 D.

Testing Machine.

A Universal 300-Ton Testing Machine. Illustrates and describes a machine in which the strength of full-sized members of structures may be tested. 1200 w. Sci Am Sup—Nov. 19, 1904. No. 66114.

MEASUREMENT.

Centrifugal Force.

The Bursting of Four-Foot Fly-Wheels. Charles H. Benjamin. An illustrated account of experimental investigations. 2200 w. Trans Am Soc of Mech Engrs, No. 017—Dec., 1904. No. 66079.

Dynamometer.

A Twist Drill Dynamometer. William W. Bird and Howard P. Fairchild. Illustrated description of a machine for measuring the twist or moment and the thrust of the drill, with some data acquired. 800 w. Trans Am Soc of Mech Engrs, No. 051—Dec., 1904. No. 66102.

Errors.

The Mechanical Principle of the Mean Error as a Measure of Precision (Die Mechanische Begründung des Mittleren Fehlers als Genauigkeitsmass). S. Wellisch. An examination of the analogy between the principle of least squares and the vibration of elastic bodies. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 4, 1904. No. 66224 D.

Fans.

Centrifugal Fans. August J. Bowie, Jr. Describes an apparatus designed by the writer to obtain a suitable velocity gauge for air which would be independent of any existing state of pressure. 2200 w. Trans Am Soc of Mech Engrs, No. 019—Dec., 1904. No. 66078.

Speeds.

Speed Indicators. Prof. Clarence P. Feldmann. General remarks on these devices and their defects, with illustrated description of the present form of the indicator invented by Hermann Frahm. 2500 w. Elec Wld & Engr—Nov. 19, 1904. No. 66184.

The Frahm Speed-Measuring Device (Frahm's Geschwindigkeitsmesser). Friedrich Lux. The vibrations set up in the mass of the observed body are determined by a selective series of vibrating springs. 1800 w. Zeitschr d Ver Deutscher Ing—Oct. 15, 1904. No. 66201 D.

Steam Meter.

An Indicating Steam Meter. C. E. Sargent. Describes a device designed by the writer, which is believed to overcome many of the difficulties which have hitherto been obstacles to success. Ill. 2500 w. Trans Am Soc of Mech Engrs, No. 028—Dec., 1904. No. 66075.

POWER AND TRANSMISSION.

Compressed Air.

A Study of Air Compressor Valves. Arthur P. Hall. An account of a recent series of tests made to study the action of these valves and the usual velocity of the air through them. Ills. 2400 w. Compressed Air—Nov., 1904. No. 66308.

Causes of Explosions in Air Compressors. Abstract of a paper by E. Goffe, and discussion, before the Mech. Engrs.' Assn. of the Witwatersrand, dealing with this subject. 1800 w. Engr, Lond—Nov. 11, 1904. No. 66305 A.

Compressed Air at the Louisiana Purchase Exposition. A review of the field of compressed air at the Exposition, showing the diversity of applications.

3500 w. Compressed Air—Nov., 1904. No. 66307.

The Application of Compressed Air to the Driving of Machine Tools (Verwendung von Pressluft Zum Antreib von Werkzeugmaschinen). Hr. Leiber. Discussing the comparative advantages of compressed, direct steam driving, belting, and electricity for driving machine tools. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 5, 1904. No. 66210 D.

Conveyors.

The Bleichert Electric Overhead Conveyor System (Das Bleichertsche Elektrohängebahn System). G. Dieterich. Illustrating and describing a system with fixed supporting rail and independently driven motor carriers using overhead roller contact trolleys. 3000 w. Elektrotech Zeitschr—Nov. 10, 1904. No. 66243 B.

Elevators.

Relative Efficiencies of Electric and Hydraulic Elevators. William C. L. Eglin. Abstract of a paper read at the Assn. of the Edison Ill. Cos. Remarks on the types of hydraulic and electric elevators, with an attempt to compare their mechanical efficiencies and the conclusions. 2000 w. Elec Rev, N Y—Nov. 12, 1904. No. 66036.

Power Plants.

See Electrical Engineering, Generating Stations.

Ropes.

Rope Transmission of Power. Frederick S. Greene. States briefly the most important advantages of rope transmission, and notes the growing use. Ills. 1500 w. Min Rept—Oct. 27, 1904. Serial. 1st part. No. 65856.

STEAM ENGINEERING.

Boiler Efficiency.

More Exact Methods for Determining the Efficiency of Steam Generating Apparatus. A. Bement. The author's views on the best method of determining the efficiency of boilers and the performance of steam generating apparatus. 2500 w. Trans Am Soc of Mech Engrs. No. 053—Dec., 1904. No. 66071.

Boilers.

A Voyage with Belleville Boilers. Editorial on a voyage recently made by the first-class cruiser Terrible, from England to Wei-hai-Wei, and back, showing the economy and steady working of the Belleville boilers. 1500 w. Engng—Nov. 18, 1904. No. 66387 A.

Staybolts, Braces and Flat Surfaces. R. S. Hale. A discussion of various rules and formulæ bearing upon the support of the flat surfaces of boilers. 3300 w. Trans Am Soc of Mech Engrs, No. 049—Dec., 1904. No. 66072.

Experiment and Practice in the Construction of Steam Boilers. Egbert P. Watson. A practical dissertation upon boiler design, discussing numerous sources of misunderstanding between maker and buyer. 3500 w. Engineering Magazine—Dec., 1904. No. 66287 B.

The Forcing Capacity of Fire Tube Boilers. F. W. Dean. Gives particulars of boiler tests upon different types of fire tube boilers, showing that the impression that these boilers have less capacity to be worked above the rated power than water-tubes, is incorrect. 2000 w. Trans Am Soc of Mech Engrs, No. 048—Dec., 1904. No. 66104.

The Schulz Water-Tube Boiler (Der Schulz Wasserrohrkessel). Carl Züblin. A general account of the Schulz modification of the Thornycroft water-tube boiler, with details of methods of manufacture, tests, and installation. Serial, Part I. 1800 w. Schiffbau—Oct. 12, 1904. No. 66270 D.

Chimneys.

Chimneys of the Interborough Rapid Transit Power House, New York City. Walter Kelsey. Illustrated detailed description of the plan of the six chimneys. 1400 w. Engr, U S A—Nov. 1, 1904. No. 65891 C.

Condensers.

Air Pumps. W. H. Booth. Considers some of the defects of independent condenser plants. 2200 w. Power—Nov., 1904. No. 65876 C.

Condensers for Steam Turbines. George I. Rockwood. On the designs for condenser systems, their cost, and especially a description of the injector or ejector condenser. 2200 w. Trans Am Soc of Mech Engrs, No. 056—Dec., 1904. No. 66070.

Connecting Rods.

Influence of the Connecting Rod Upon Engine Forces. Sanford A. Moss. Deduces a method for simply and yet exactly taking account of the influence of the weight and inertia of the connecting rod upon the forces transmitted by the ordinary slider crank-chain, such as is used in steam and gas engines. 3800 w. Trans Am Soc of Mech Engrs, No. 018—Dec., 1904. No. 66106.

Draft.

Draft in Ash Pans. Presented before the North-West Ry. Club. Extracts from replies to a letter of inquiry, with report of tests. 4000 w. Ry & Engng Rev—Nov. 26, 1904. No. 66377.

Engines.

Losses in Non-Condensing Engines.

James B. Stanwood. An extension of the discussion upon the relation of these losses, especially such as occur in non-condensing engines, with analysis of tests of a few leading types of these engines. 5400 w. Trans Am Soc of Mech Engrs. No. 034—Dec., 1904. No. 66105 C.

Interesting Results of the Tests of a Reeves Simple Engine. H. Diedrichs. Condensed report of a series of tests made to determine the steam consumption, mechanical efficiency and general behavior of the engine under various conditions of load. 1000 w. Sib Jour of Engng—Nov., 1904. No. 66087 C.

Exhaust Steam.

The Quality of Exhaust Steam. C. V. Kerr. Gives formulæ for determining the quality of the exhaust, and their application. 1200 w. Stevens Ind—Oct., 1904. No. 66401 D.

Utilization of Exhaust Steam in Connection with Low Pressure Steam Turbines. Mons. Leonce Battu. Presents the advantages of the Rateau system and some of its applications. Discussion and illustrations. 12000 w. Jour W Soc of Engrs—Oct., 1904. No. 66096 D.

Feed-Water.

Feed-Water Heating. R. T. Strohm. Discusses the economy, safety and purification secured by heating the feed-water, and the methods used. Ills. 2200 w. Am Elect'n—Nov., 1904. No. 65909.

On Some Water Softeners of a Novel Design. Dr. Alfred Gradenwitz. Illustrated description of the Breda water softener, with general remarks. 1800 w. Prac Engr—Nov. 4, 1904. No. 66043 A.

Purification of Water for the Production of Steam. J. O. Handy. Abstract of a paper read before the Int. Cong., St. Louis. A review of the methods for the removal of scale-forming matter as used in the United States. 6200 w. Elec Rev, N Y—Nov. 12, 1904. No. 66035.

Flue Gases.

Flue Gas Testing. W. H. Whysall. Illustrates and describes methods of testing, explaining the value of the information obtained. 2700 w. St Ry Rev—Oct 20, 1904. No. 65895 C.

Foaming.

A Bad Case of Discharge of Water with Steam from Water-Tube Boilers. A. Bement. An illustrated account of the investigations made to determine the cause and the remedies. 7000 w. Trans Am Soc of Mech Engrs, No. 020—Dec., 1904. No. 66077 C.

Marine Engines.

See Marine and Naval Engineering.

Navy Report.

See Marine and Naval Engineering.

Nozzles.

Pressures and Temperatures in Free Expansion. A. Borsody and R. Campbell Cairncross. Tables and diagrams, obtained experimentally, on the pressures in nozzles. Trans Am Soc of Mech Engrs, No. 055—Dec., 1904. No. 66099 C.

Pipe Joints.

Pipes and Joints for High Pressures. Franklin Riffle. Discusses the several types of pipes and joints that have recently been used for high pressures in the transmission of water, steam, and gas, with especial reference to Pacific Coast practice. Ills. 4200 w. Jour Assn of Engng Socs—Sept., 1904. No. 66165 C.

Unions and Flanges: Their Construction and Merits. Read before the Assn. of Steam Engrs. Discusses the various constructions of union couplings for steam pipes, with a view to determining the best design. 2300 w. Can Engr—Nov., 1904. No. 65990.

Piping.

High Pressure Steam Pipe Systems. Franz Koester. An illustrated review and comparison of late practice on the continent of Europe and in America. 3300 w. St Ry Rev—Oct. 20, 1904. No. 65894 C.

Power Plants.

See Electrical Engng., Generating Stations.

Smoke.

The Smoke Problem. F. J. Rowan. Considers the production, estimation, and prevention of smoke and the subject of municipal control. 2 plates. Discussion. 11000 w. Trans Inst of Engrs & Shipbuilders in Scotland—Oct. 25, 1904. No. 66411 D.

Specific Heat.

The Specific Heat of Superheated Steam. Sidney A. Reeve. Reviews information from various investigators and calls attention to the unsatisfactory present state of knowledge on this subject, urging its reinvestigation. 4000 w. Jour Worcester Poly Inst—Nov., 1904. No. 66410 C.

Steam Pumps.

See Mechanical Engng., Hydraulics.

Steam Turbines.

Simple Steam Turbine Engines. John Richards. Discusses the design, construction and operation of the various classes of these motors. Ills. 7500 w. Jour Assn of Engng Socs—Sept., 1904. No. 66163 C.

Steam Turbines (Dampfturbinen). M. F. Gütermuth. A review of the more recent steam turbines with diagrams showing the results of numerous tests. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 15, 1904. No. 66200 D.

Test on 500-Kilowatt Curtis Turbine Set at Cork. Gives the principal results of a series of trials on steam consumption, made by Charles H. Merz. 500 w. Engng—Nov. 18, 1904. No. 66385 A.

The De Laval Steam Turbine and Its Manufacture. Illustrated article describing details in the construction, and the methods of manufacture in the American works at Trenton, N. J. 4500 w. Mach, N Y—Nov., 1904. No. 65879 C.

See Marine and Naval Engineering.

Superheating.

The Assistance of Superheated Steam for Reducing the Cost of Electrical Energy. E. J. Fox. Remarks giving the writer's experience and showing the subject is deserving of the attention of those interested in the generation of electricity. 1500 w. Ir & Coal Trds Rev—Nov. 4, 1904. No; 66047 A.

Valves.

Steam Closing Stop Valves for Boilers. A. B. Willits. Illustrates and describes the old form of automatic stop valve, the advance to a steam closing stop valve, and the latest form. 1500 w. Ir Age—Nov. 24, 1904. No. 66317.

MINING AND METALLURGY

COAL AND COKE.

Briquettes.

The Improvement of Briquette Fuel for Minimising Smoke Production (Aufbesserung der Stein kohlen briketts zwecks Rauchverminderung). H. Schöndeling. Showing the influence of a suitable binding material and a heavy moulding pressure upon the smokelessness of briquettes. 1200 w. Glückauf—Nov. 5, 1904. No. 66261 D.

Charcoal.

Charcoal Fuel in the Ural (Holzkohlensorten in Ural). Ed. Juon. An account of the varieties of charcoal made in the iron districts of the Urals, furnishing practically the entire fuel for the Russian blast furnaces. 4000 w. Stahl u Eisen—Nov. 1, 1904. No. 66257 D.

Coal Cutting.

Two Years' Experience in Winning Coal by Machinery. F. O. Kirkup. Read before the N. Y. Eng. Branch of the Nat. Assn. of Col. Mgrs. An account of the writer's experience. Also discussion. 4000 w. Ir & Coal Trds Rev—Nov. 18, 1904. No. 66397 A.

Coal Mining.

See Industrial Economy.

Coke.

The German Coke Industry in the Last Ten Years (Die Deutsche Koksindustrie in den Letzten Zehn Jahren). Oskar Simmersbach. With statistics and diagrams showing the output of the various districts. 3000 w. Stahl u Eisen—Oct. 15, 1904. No. 66254 D.

Collieries.

Power Plants at Collieries. Discusses the principal economies that may be applied to modern collieries in Great Britain and the saving that would result. 1800 w. Mech Engr—Oct. 29, 1904. No. 65974 A.

Dawdon Colliery.

The New Winning at Dawdon Colliery A report of progress at the Thereau pit and the Castlereagh pit. These shafts are to be sunk to a depth of 1800 ft. and are 20 ft. in diameter. 1200 w. Col Guard—Nov. 18, 1904. No. 66383 A.

Explosions.

Coal Dust Explosions in Upper Silesia (Ueber Kohlenstaub explosionen in Oberschlesien). H. Knochenhauer. Detailed accounts of a number of explosions in coal mines, due to the ignition of the dust in the air. 5000 w. Glückauf—Oct. 29. 1904. No. 66260 D.

Hungary.

Coal in Hungary. From a monograph by Alexander von Kaliezinsky. On the character of the deposits and the development. 700 w. Eng & Min Jour—Nov. 24, 1904. No. 66327.

New Fields.

The Alberta Coal Field. L. K. Armstrong. General information concerning the Canadian coal fields of Alberta and East Kootenay in British Columbia. Map. 1500 w. Min Rept—Nov. 24, 1904. No. 66337.

South Wales.

The Coal Measures of the Valley of the Gwendraeth-farm in South Wales. T. C. Cantrill and E. E. L. Dixon. From the Genl. Surv. of the United Kingdom . An account of the veins and their working. faults, disturbances, etc. 4000 w. Ir & Coal Trds Rev—Nov. 4, 1904. No. 66049 A.

Spontaneous Combustion.

The Reduction of Risk from Fires Caused by Spontaneous Combustion of Soft Coal. Advice from a bulletin of the Home Insurance Co., of New York, prepared bv F. M. Griswold. 800 w. Eng News—Nov. 10, 1904. No. 65997.

Washington.

Notes on the Mines of Kittitas County, Washington. J. D. Bone. An account of a remarkably rich region yielding abundance of bituminous coal, and also gold, copper and iron. 1000 w. Min Rept—Oct. 27, 1904. No. 65858.

COPPER.

Arizona.

The Genesis of the Copper-Deposits of Clifton-Morenci, Arizona. Waldemar Lindgren. A résumé of some of the conclusions reached during a study of the copper-deposits near Clifton. 14000 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 66357 C.

The Silverbell Mountains, Arizona. W. G. Barney. Describes this region brought into notice by the recent building of the Arizona Southern R. R., and the copper deposits being developed. 1300 w. Eng & Min Jour—Nov. 10, 1904. No. 66004.

Assaying.

The Iodimetric Determination of Copper. Andrew M. Fairlie. Describes a method which claims to have eliminated all the objectionable features of the precipitation by aluminum. 1400 w. Eng & Min Jour—Nov. 17, 1904. No. 66124.

Colorado.

Copper Mining in the Encampment, Wyoming, and Pearl, Colorado, Districts. Thomas T. Read. Considers these districts on the Wyoming-Colorado boundary, describing the development. 800 w. Min Rept—Nov. 3, 1904. No. 65963.

Electro-Metallurgy.

See Electrical Engineering, Electro-Chemistry.

Native.

Mass Copper. Extracts from reports published in 1857, 8, & 9, in regard to development at the Minnesota mines. 2000 w. Eng & Min Jour—Nov. 10, 1904. No. 66001.

Ore Deposits.

Copper Ores in the Cascade Mountains. R. H. Stretch. Map with notes on the connection of the sulphide ores of copper with the associated rocks. 2000 w. Eng & Min Jour—Nov. 17, 1904. No. 66125.

The Theory of Copper Deposition. Alfred C. Lane. A review of what is known concerning the copper of Lake Superior and of the theories regarding the origin. 4000 w. Am Geol—Nov., 1904. No. 66060 D.

Smelting.

Roasting at the Tyee Smelter. E. Jacobs. Describes the treatment of the ore before it reaches the furnace, particularly the arrangement, appointments and operating methods of the roasting yard. The ore is principally chalcopyrite carrying gold, silver and zinc as well as copper. Ills. 1500 w. Eng & Min Jour—Nov. 10, 1904. No. 66000.

Yukon.

White Horse Copper Camps, Yukon Territory. W. M. Brewer. An account of the development of southern Yukon and its mines, and some of the difficulties encountered. 2500 w. Min & Sci Pr—Nov. 5, 1904. No. 65038.

GOLD AND SILVER.

Black Hills.

The Ore Deposits of the Northern Black Hills. T. D. Irving. Describes this productive region and its ore deposits. 2000 w. Min Rept—Oct. 27, 1904. No. 65855.

British Columbia.

Smelters and Smelting Practice in British Columbia. William M .Brewer. An illustrated review of the rapid growth and expansion of the smelting industry in the last fifteen years. 4000 w. Engineering Magazine—Dec., 1904. No. 66283 B.

Crushing.

Crushing in Cyanide Solution, as Practiced in the Black Hills, South Dakota. Charles H. Fulton. Describes the character of the ores the general features of the process, the precipitation, etc., giving the cost of treatment. 8000 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 66365 C.

Cyanide.

Cyanide Practice at the Maitland Properties, South Dakota. John Gross. Describes the ore, and the mill practice, giving statistical data based on a daily tonnage of from 110 to 120 tons. Ills. 5000 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 66364 C.

Deep Leads.

The Deep Leads of Victoria. H. L. Wilkinson. A description of these auriferous deposits, their location, draining and working. Map. 2200 w. Aust Min Stand—Oct. 20, 1904. Serial. 1st part. No. 66378 B.

Laboratory.

The equipment of a Laboratory for a Smelting-Plant. Hubert Haas. Describes a laboratory for metallurgical chemistry and technical analyses built by the writer in California. 2000 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 66363.

Ontario.

The Mines of Ontario. W. E. H. Carter. Read before the Can. Min. Inst. A brief review of the present status of the mining industry, especially in western Ontario. The gold mines, placers, etc. are dealt with in the present article. 3000 w.

Can Min Rev—Oct. 31, 1904. Serial, 1st part. No. 65958 B.

Oregon.

The Granite Hill Mines of Southern Oregon. An account of the development of these gold-quartz mines, with illustrations. 1400 w. Min & Sci Pr—Nov. 5, 1904. No. 66039.

Ores.

Preliminary examining of Milling Ores. Alfred Harvey. On the importance of testing ores to minimize the risk in designing a mill to treat an ore satisfactorily. 1200 w. Min & Sci Pr—Oct. 29, 1904. No. 65966.

Patio Process.

The Modern Patio Process. Arthur H. Halloran. Describes the primitive method used in Mexico, Peru, and Chili, and recent improvements introduced which even further simplifies and cheapens this method. 1500 w. Illus. Min & Sci Pr—Oct. 29, 1904. No. 65967.

Precipitate.

Some Studies on "the White Precipitate" Formed in the Zinc Boxes of the Cyanide Works. Prof. A. Prister and Dr. B. Bay. Gives analyses made to determine the total cyanide, and the bases present in the white precipitate. Brief discussion. 4500 w. Jour of Chem, Met, & Min Soc of S Africa—Sept., 1904. No. 66175 E.

Rand.

Mining and Metallurgy on the Rand. E. M. Weston. Gives a record of recent progress. 2800 w. Aust Min Stand—Oct. 6, 1904. Serial. 1st part. No. 66351 B.

The Analyses of Some Witwatersrand Soils. Edw. H. Croghan. General discussion. 3000 w. Jour of Chem, Met, & Min Soc of S Africa—Sept., 1904. No. 66176 E.

Yukon.

Hydraulicking in the Yukon Region. C. R. Settlemeier. Describes the conditions of this region and the methods used. Ills. 2700 w. Min & Sci Pr—Nov. 19, 1904. No. 66338.

IRON AND STEEL.

Blast-Furnaces.

Improvements in the Mechanical Charging of the Modern Blast-Furnace. David Baker. An illustrated account of skip-hoist experiments, and the conclusions. 4000 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 66358 C.

Notes on the Blast-Furnace. John M. Hartman. Suggestions for the management of blast-furnaces. 3000 w. Ir Trd Rev—Nov. 10, 1904. No. 66019.

Special Forms of Blast-Furnace Charging-Apparatus. T. F. Witherbee. Illustrated description of various forms of charging apparatus, suggesting that better results in running may be had by charging nearer to the center. 1800 w. Trans Am Inst of Min Engrs—Sept., 1904. No. 66362.

The Pyrometer in Blast-Furnace Practice. S. H. Stupakoff. Read before the Pittsburg Found. Assn. Gives details of interest in regard to the application of the thermo-electric pyrometer to blast-furnaces, with brief remarks on other pyrometers. 3300 w. Am Mfr & Ir Wld—Nov. 17, 1904. No. 66119.

Dunderland Mines.

The Edison Process at the Dunderland Mines. W. Simpkin and J. B. Ballantine. Read before the Inst. of Min. & Met. Brief illustrated description of the Edison process of crushing and grinding as it has been applied to iron ore franklinite, limestone, etc. 3500 w. Ir & Coal Trds Rev —Oct. 28, 1904. No. 65987 A.

Ferro-Titanium.

The Titaniferous Charcoal Iron of Turrach in Upper Styria (Ueber Titanhaltiges Holzkohlen-Roheisen von Turrach in Obersteiermark). J. Hörhager. Giving analyses of the irons showing their availability for the production of ferro-titanium. 3500 w. Oesterr Zeitschr f Berg u Huttenwesen—Oct. 22, 1904. No. 66234 D.

Fine Ores.

The Injurious Action of Fine Ores upon the Blast Furnace (Feinerze als Ursache von Hochofenstörungen). Dr. Aloys Weiskopf. An examination of the manner in which fine ores erode the interior of the furnace and affect the working. 3500 w. Stahl u Eisen—Nov. 1, 1904. No. 66256 D.

Iron Industry.

See Industrial Economy.

New District.

A New, Promising Lake Superior Iron District. Kirby Thomas. Describes the Cuyuna district in Minnesota. Map. 2500 w. Min Wld—Nov. 5, 1904. No. 65941.

Ore-Handling.

Ore-Handling Machinery on the Great Lakes. Illustrated description of some of the more important varieties of ore handling machinery in use, showing the method of removing the ore from vessels and placing it on cars. 4400 w. Naut Gaz—Nov. 3, 1904. No. 65961.

Pig Iron.

Notes on Southern Pig Iron. Eliot A. Kebler. Read before the Pittsburg Found. Assn. Information of interest. 1200 w. Ir Age—Nov. 17, 1904. No. 66110.

Rolling Mills.

Some of the Significant Features of American Rolling Mill Practice. D. F.

Nisbet. Notes on steam generation, engines for roll trains, hydraulic systems, electrical appliances, ingot stripping, pit furnaces, mills, etc. Ills. 6000 w. Ir Trd Rev—Oct. 27, 1904. No. 65863.

The New Universal Mill of the Burbach Works (Die Neue Universalstrasse der Burbacher Hütte). Fr. Frölich. Details and photographs of a mill built by the Duisburg works and installed at Burbach, including direct-connected engine and steam plant. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1904. No. 66206 D.

Smelting.

Electric Smelting of Iron and Steel. J. H. Stansbie. Read before the Staffordshire Iron & Steel Inst. Brief notes on the construction and working of the electric furnace and its use for smelting purposes. 1200 w. Ir & Coal Trds Rev—Nov. 4, 1904. No. 66048 A.

Tropenas Process.

The Small Converter Problem. Arthur Simonson. Information explanatory of the Tropenas Steel Process and its advantages. 2800 w. Foundry—Nov., 1904. No. 65889.

MINING.

Compressed Air.

Compressed Air in Mine Operation. Lucius I. Wightman. An advocacy of compressed air for mining work, presenting its advantages. Ills. 2500 w. Min Mag—Oct., 1904. No. 66084 C.

Greece.

The Mines of Laurium, Greece. Henry F. Collins. Describes the geology of the region, and the deposits of silver, lead, iron, and zinc ores. Ills. 3000 w. Eng & Min Jour—Nov. 10, 1904. No. 66003.

Haulage.

Electrical and Steam Haulage. Neil Hutchings. An illustrated description of the haulage system at Slope No. 3, Pratt mine, of the Tennessee Coal, Iron & Railroad Co., at Ensley, Alabama. 2200 w. Mines & Min—Nov, 1904. No. 65930 C.

Electric Mine Haulage. W. B. Clarke. Considers the electric mine locomotive and its adaptation to underground haulage. Ills. 2000 w. Min Mag—Oct., 1904. No. 66083 C.

Notes on the Application of an Oil Engine to Main and Tail and Endless Rope Haulage Combined. W. C. Blackett. Read before the N. of Eng. Branch of the Nat. Assn. of Col. Mgrs. An account of the use of oil ngines in secondary haulage, describing the method. Ills. 2000 w. Ir & Coal Trds Rev.—Nov. 18, 1904. No. 66398 A.

Hoisting.

Head-Frames and Hoists in the Joplin District. W. R. Crane. Illustrates and describes the construction of head-frames and the methods of hoisting employed in the lead and zinc mines, which differ greatly from those used in other districts. 4000 w. Min Mag—Oct., 1904. No. 66081 C.

Hoists and Hoisting in the Interior Coal Fields. George S. Rice. Describes the arrangements where the conditions to be met are shallow shafts, rapid hoisting, and small labor costs. Ills. 2200 w. Min Mag—Oct., 1904. No. 66082 C.

Improved Controlling Appliances for Winding Engines (Nouveaux Evite-Molettes). H. Schmerber. Describing especially the electric and other systems, shown at the exposition at Arras, for controlling and regulating winding engines for mines together with brakes and safety appliances. Two articles. 3000 w. Génie Civil—Oct. 22, 29, 1904. No. 66213 each D.

Present Practice of Deep Hoisting on the Mines of the Rand. J. B. Carper. Description, with illustration, of the Whiting system and its application to these mines, the cost, etc. 1800 w. Min Jour—Nov 12, 1904. No. 66173 A.

The Electric Winding Plant at the Ligny-les-Aire Mines Elektrische Fördermaschine für die Compagnie des Mines de Ligny-les-Aire). Details and general arrangement of winding plant for a depth of 400 metres, installed in Northern France. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1904. No. 66204 D.

The Hoisting Problem. James R. Thompson. Read before the Lake Superior Min. Inst. Discusses the relation of the underground requirements, the engineering, mechanical and financial consideratons. 5000 w. Mines & Min—Nov., 1904. No. 65932 C.

The Tamarack Hoisting Engine. Illustrates and describes an engine having interesting features and a capacity of 5000 h. p. 2000 w. Power—Nov., 1904. No. 65874 C.

Mining Debris.

Débris-Restraining Barriers of the Yuba River. Capt. Wm. W. Harts. An illustrated article explaining the plan proposed by the California Débris Commission for the treatment of this river which suffered from the accumulation of mining detritus. 3000 w. Sci Am Sup—Nov. 19, 1904. No. 66118.

Ore Elevators.

Notes on Ore Bucket Elevators. Alfred Harvey. Describes a few types most commonly used, giving information in regard to satisfactory speeds and diameters of head pulleys. Ills. 1500 w. Min Rept—Nov. 17, 1904. No. 66174.

Respirator.

Recent Investigations upon the Use of a Working Respirator Apparatus (Neue Untersuchungen über die Erfordernisse eines zur Arbeit Brauchbaren Rettungsapparates). B. Dräger. Describing recent devices for artificial respiration for life-saving service in mines. 3000 w. Glückauf—Oct. 15, 1904. No. 66259 D.

Shafts.

A Concrete-Lined Shaft for the U. S. Coal & Coke Co. Francis Donaldson. Illustrated description of two elliptical shafts, lined with concrete, recently completed in W. Va. 1200 w. Eng News—Nov. 3, 1904. No. 65925.

Richmond No. 3 Shaft. Frank G. Wolfe. Illustrates and describes methods employed in sinking through quicksand near Scranton to connect with workings below. 1500 w. Mines & Min—Nov., 1904. No. 65933 C.

Shaft Sinking Through Quicksand. H. B. Sturtevant. From Pro. of L. Sup. Min. Inst. A description of methods employed at Susquehanna mine, Hibbing, Minn. 1800 w. Mines & Min—Nov., 1904. No. 65934 C.

Valuation.

Variation of Ore Values—Caution in Valuing Mines. A. Lakes. Observations of an experienced mine examiner. 1200 w. Min Rept—Nov. 3, 1004. No. 65965.

Ventilation.

Small Quick-Running Fans for Mine Ventilation. James Tonge. An illustrated account of some new ventilators for this purpose and the advantages claimed. 1700 w. Mines & Min—Nov., 1904. No. 65929 C.

MISCELLANY.

Aluminium.

Note on a Suggested New Source of Aluminium. Buena Pool. On the utilization of the laterite deposits of India, in which the aluminium is present in the hydrated form. 1200 w. Elec Engr, Lond—Oct. 28, 1904. No. 65976 A.

Bitumen.

Bitumen: Its Consumption in the United Kingdom and Its Production in Trinidad. W. Pollard Digby. Shows the volume and source of the United Kingdom's import of bitumen for the last 15 years. 1000 w. Elec Engr, Lond—Oct. 28, 1904. No. 65977 A.

Chile.

A Geological Cross-Section of the Western Cordillera Along the Rio Husses. A record of facts collected during several hurried journeys, with topographical map and a cross-section. 2800 w. Trans Am Inst of Min Engrs—Nov., 1904. No. 66360.

Fluor Spar.

Fluor Spar Deposits of the Kentucky-Illinois District. H. Foster Bain. On the grades and genesis of the ore, and the geology of the district. 2500 w. Mines & Min—Nov., 1904. No. 65931 C.

Manganese.

Manganese. Lionel C. Ball. Introductory to reports on the manganese deposits of Queensland, dealing with the mineralogy, chemistry, metallurgy, uses, markets, and occurrence. 4500 w. Queens Gov Min Jour—Sept. 15, 1904. No. 65905 B.

Manganese in Cyanide Solutions. J. E. Clennell. Describes a process based on the method given by C. and J. Beringer for the colorimetric estimation of manganese in ores and compounds free from chlorides. 600 w. Eng & Min Jour—Nov. 24, 1904. No. 66325.

Oil Region.

The Flathead Valley—A Description of the New East Kootenay Oil Region. D. B. Boyle. Illustrated. 900 w. B C Min Rec—Nov., 1904. No. 65989 B.

Quicksilver.

Quicksilver in Pan Amalgamation. W. J. Adams. An explanation of the causes of the flouring of quicksilver. 900 w. Min & Sci Pr—Nov. 5, 1904. Serial. 1st part. No. 66037.

Slags.

The Formation of Slags in Metallurgical Operations (La Formation des Scories dans les Operations Métallurgiques). W. Mathesius. An examination of the chemical composition of various slags, their formation, and some of their useful applications. 4000 w. Rev Gen des Sciences—Oct. 15, 1904. No. 66235 D.

Tin.

Tin in the United States. F. Lynwood Garrison. Briefly reviews the localities where tin has been found and exploited, commenting on the recent discovery of tin in Alaska. 3000 w. Eng & Min Jour—Nov. 24, 1904. No. 66328.

Tungsten.

Tungsten: Its Use and Value. States the chief sources, with some of its uses, and present value. 900 w. Eng & Min Jour—Nov. 10, 1904. No. 66002.

Vanadium.

Extraction of Vanadium from Natural Vanadate of Lead (Extraction du Vanadium du Vanadate de Plomb Naturel). H. Herrenschmidt. Describing the treatment used for the vanadate of lead from the Santa Marta mines, Spain, and the subsequent production of ferro-vanadium. 800 w. Comptes Rendus—Oct. 24, 1904. No. 66232 D.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Railroad Accidents in the United States. Edward A. Moseley. Comments on the increase in railroad accidents, discussing the causes, and suggesting remedies. 4200 w. Rev of Revs—Nov., 1904. No. 65907 C.

The Causes of Accidents on American Railways. F. W. Haskell. Attributing the frequency of disasters to official connivance in the habitual disregard of rules. 4000 w. Engineering Magazine—Dec., 1904. No. 66282 B.

Operation.

Railroad Operation in the United States. Sidney Graves Koon. An investigation of the general tendency in recent years, based on statistics given in a paper by H. Ward Leonard. 1200 w. Sib Jour of Engng—Nov., 1904. No. 66089 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Train Pipe Leakage, and Speed of Air Pump. P. J. Langan. On the importance of maintaining the equipment, the effect of fast running on pumps, their need of inspection, etc. 2000 w. Loc Engng—Nov., 1904. No. 65969 C.

Cars.

First-Class Salon for the South-Eastern and Chatham Railway. Illustrated description of handsome first-class carriages. 2-page plate. 700 w. Engng—Oct. 28, 1904. No. 65982 A.

Steel Cars. Extracts from a paper by J. F. MacEnulty, read at meeting of the New England R. R. Club. Presents the advantages of this type of construction, and attempts to show that such cars are more economical than modern cars. 2000 w. R R Gaz—Vol. XXXVII., No. 24. No. 66329.

Combustion.

Combustion, or the Source of Energy in the Locomotive. T. J. Henderson. A discussion of the question of fuel economy. 4000 w. Pro Pacific C Ry Club, Oct. 15, 1904. No. 66080 C.

Electric Locomotives.

Construction and Characteristics of Electric Locomotives for the New York Central & Hudson River R. R. Illustrated detailed description, calling attention to the new features. 3000 w. Eng News—Nov. 17, 1904. No. 66134.

Electric Railway Locomotives for the New York Central. Illustration and principal dimensions of these locomotives, with description and general remarks. 1400 w. Sci Am—Nov. 12, 1904. No. 66007.

North-Eastern Railway Electric Locomotive. Illustrated detailed description. 1500 w. Tram & Ry Wld—Nov. 10, 1904. No. 66356 B.

The First Electric Locomotive for the New York Central. Illustrated description of the powerful high-speed electric locomotive officially tried at Schenectady on Nov. 12. 2500 w. Ir Age—Nov. 17, 1904. No. 66108.

Fire Box.

Locomotive Boiler with Water-Tube Fire Box (Lokomotivkessel mit Wasserrohr Feuerbuchse). G. Elbel. A description of the Brotan boiler, combining a water-tube fire box with the fire-tube shell. 2000 w. Glasers Annalen—Oct. 15, 1904. No. 66225 D.

India.

A New Indian Train de Luxe. Illustrated description of a special limited express between Bombay and Poona. 1000 w. Loc Engng—Nov., 1904. No. 65968 C.

Locomotives.

A Proposed Compound Express Locomotive. Chas. S. Lake. Illustrates and describes a 4-4-2 passenger engine compounded on Mr. Rickie's system, discussing its use for highest grade express passenger duty under British restrictions. 2200 w. Transport—Oct. 28, 1904. No. 65971 A.

A Trip on the Big 2700. Angus Sinclair. Describes a ride on a four-cylinder balanced compound locomotive on the C. B. & Q. R. R. 1500 w. Loc Engng—Nov., 1904. No. 65970 C.

Baldwin Four-Cylinder Balanced Compound Locomotive. W. J. McCarroll. Read before the Traveling Engrs'. Assn. Remarks on the value of compounding, with illustrated description of this engine and its action. 3800 w. Ry & Engng Rev —Nov. 12, 1904. No. 66040.

Boston & Maine 10-Wheel Passenger Locomotive. Illustrations and discussions of powerful engines. 500 w. Ry Age—Nov. 11, 1904. No. 66018.

Eight-Coupled Locomotive for Goods Traffic; Great Central Railway. Brief, illustrated description, with two-page plate. 400 w. Engng—Nov. 18, 1904. No. 66390 A.

Fuel Consumption of Locomotives. G. R. Henderson. Gives a diagram for solving problems in fuel consumption, with explanation of its use. 2300 w. Trans Am Soc of Mech Engrs, No. 046—Dec., 1904. No. 66073.

German Four-Cylinder Balanced Compound Locomotive, with Superheater, at the St. Louis Exhibition. Illustrated detailed description of this engine, which is one of 30 engines for the Prussian State Railways. 1800 w. Eng News—Nov. 24, 1904. No. 66332.

New Locomotives for the Paris Belt Railroad. Abstract of an article by J. Koechlin, in the *Revue Generale des Chemins de Fer.* Illustrated description of engines designed for local passenger service. 2300 w. R R Gaz—Vol. XXXVII, No. 21. No. 65918.

Powerful Prairie Type Passenger Locomotives. Illustration, description, and general dimensions of the heaviest passenger locomotives ever built, noteworthy for their power, heavy wheel loads and the wheel arrangement. 700 w. Am Engr & R R Jour—Nov., 1904. No. 65880 C.

Recent Locomotive Work on the London and North-Western Railway. Charles Rous-Marten. A review of the manner in which the time-table promises have been fulfilled. The present article especially considers Mr. Whale's new engines. 2800 w. Engr, Lond—Nov. 4, 1904. Serial. 1st part. No. 66054 A.

Standard Locomotives for the Southern Pacific. Illustrations, with brief descriptions of engines of the consolidation, Atlantic, Pacific, and 6-wheel switching types. 400 w. Ry Age—Nov. 25, 1904. No. 66315.

The Mallet Articulated Locomotive at the St. Louis Exhibition. H. W. Hanbury. Especially discusses the intercepting, reducing and emergency valves, which are the leading feature of the Richmond System of Compounding. 1500 w. Engng—Nov. 11, 1904. No. 66199 A.

Locomotive Trials.

Comparative Trials of Locomotives Using Saturated Steam and Using Moderately Superheated Steam. Wm. Strohl, in *Zeitschrift des Ver. deut. Ing.* Abstract of report of trials on the Prussian State Railway. 4900 w. Bul Int Ry Cong—Oct., 1904. No. 66181 E.

Road Tests of Brooks Passenger Locomotives. E. A. Hitchcock. Gives results representing every-day practice on two types of machines, giving illustrated description of apparatus, and methods. 2700 w. Trans Am Soc of Mech Engrs, Nov. 054—Dec., 1904. No. 66100 C.

Locomotive Valves.

The Young Valve and Gear for Locomotives. Illustrated detailed description of a system of rocking valves, designed by O. W. Young and carefully tested. 2000 w. R R Gaz—Vol. XXXVII, No. 21. No. 65919.

Motor Cars.

Auto Cars on French Railways. Illustrates and describes types put in service, especially the Purrey carriages. 1600 w. Ry Age—Nov. 11, 1904. No. 66016.

Extension of the Great Western Motor Coach Services. Gives information concerning this service and its success. 1500 w. Engr, Lond—Nov. 4, 1904. No. 66056 A.

New Steam Motor Cars for Railway Service (Neue Dampfmotorwagen im Eisenbahnbetrieb). Dr. Alfred Brunn. With numerous illustrations of self-propelled cars for local and special service. Two articles. 6000 w. Ill. Zeitschr f Klein u Strassenbahnen—Oct. 19, Nov. 2, 1904. No. 66280 each D.

The Use of Independent Motor Cars on Railways. Philip Dawson. A discussion of this subject, describing the various motor cars that have come into use and concluding that the car driven by a petrol. or gasoline motor is the best thus far tried. 11000 w. St Ry Jour—Nov. 5, 1904. No. 65942 C.

Resistance.

Train Resistance. Chester A. Crandall. Gives first a comparison of the calculated with the actual train resistance; second, an analysis of the several factors which influence train resistance; third, a comparison of the best-known formulæ. 1200 w. R R Gaz—Vol. XXXVII, No. 21. No. 65920.

Superheating.

The Application of Superheated Steam to Locomotives (Die Anwendung des Heissdampfes im Lokomotivbetriebe). Ernst Happel. A discussion of the economy to be effected, and a description of a simple form of superheater for locomotive boilers. 1200 w. Glasers Annalen—Nov. 1, 1904. No. 66227 D.

Train.

The New Haven's Merchants' Limited Train. Illustrates and describes two complete new Pullman trains placed recently on 5-hour service between New York and Boston. 800 w. Ry Age—Nov. 25, 1904. No. 66314.

Truck.

A New Des' n of Steel Motor Truck for Heavy Electric Traction Service. Illustrates and describes a truck for heavy high-speed electric railway operation. 1500 w. St Ry Jour—Oct. 29, 1904. No. 65865 C.

Water Glasses.

The Breakage of Tubes of Water-Level Indicators (Rupture des Tubes Indicateurs de Niveau d'Eau). M. Defauconpret. Describing the devices used on the Northern Railway of France for the protection of the men from injury by the breakage of water-glass tubes. 2500 w. Rev Gen d Chem de Fer—Sept., 1904. No. 66249 G.

NEW PROJECTS.

Argentina.

Argentine Railway Progress. Charles M. Pepper. An account of the activity in railway enterprises, with map showing lines built and projected. 1500 w. Ry Age —Nov. 11, 1904. No. 66017.

Lake Baikal.

The Lake Baikal Railway. Particulars from the report of a Russian engineer in regard to this recently completed section of the great Siberian Railway. 2000 w. Engng—Nov. 18, 1904. No. 66388 A.

New Road.

The Grand Trunk Pacific. A reprint, almost in full, of an article by W. L. Mackenzie King, in the *Quarterly Journal of Economics*, which analyses in detail the agreement made by the Canadian Government, and comments on the policy to be tried. 4500 w. R R Gaz—Vol. XXXVII, No. 24. No. 66331.

PERMANENT WAY AND BUILDINGS.

Berlin.

The Construction of the Görlitz Railway and Its Connections Between Berlin and Grünau (Ausbau der Görlitzer Vorortstrecke und ihrer Anschlusse zwischen Berlin und Grünau). H. Biedermann. An illustrated account of recent extensions of suburban railway connections in the vicinity of Berlin. 4000 w. 2 plates. Glasers Annalen—Nov. 1, 1904. No. 66226 D.

Blacksmith Shop.

Equipment for a Modern Blacksmith Shop for Railroad Work. A. W. McCaslin. Presented before the Nat. R. R. Mas. Blacksmiths' Assn. Describes the requirements of a model shop. 2300 w. Ry Mas Mech—Nov., 1904. No. 65988.

China.

The Actual Building of a Chinese Railway. Justin Burns. The second article describes the earthwork, bridges, track and train service of the Canton-Hankow Railway. 4000 w. Engineering Magazine —Dec., 1904. No. 66286 B.

Cross-Ties.

The Railroad Cross-Tie Problem. S. Whinery. Considers the subject of cross-ties and other forms of support for tracks, giving a summary of the conclusions reached and some of the reasons leading to them. Ills. 2500 w. R R Gaz—Vol. XXXVII, No. 21. Serial. 1st part. No. 65921.

Curves.

Vertical Railway Curves. H. J. Randall. Considers curves to round off the angle made by the change of grade, discussing what justification there is for making the curve from 200 to 400 feet or more in length, showing the advantage of increasing the length is much greater for short trains than long ones. Ills. 5000 w. Jour Assn of Engng Socs—Sept., 1904. No. 66166 C.

Improvements.

Improvements on the Morris & Essex Division of the Lackawanna R. R. Explains recent changes made necessary by the great increase in population near New York, describing and illustrating important features of the work. 3500 w. Eng Rec—Nov. 12, 1904. Serial. 1st part. No. 66025.

Rails.

On the Discussion of Rails for Lines with Fast Trains (Subject II., for Discussion at the Seventh Session of the Railway Congress). J. W. Post. Investigation of the question in general and the experience, in particular, of certain managements mentioned, with conclusions. 7400 w. Tables and figures. Bul Int Ry Cong—Oct., 1904. No. 66178 E.

Rail Bonding. A. Henrick Jackson. An illustrated article based on information from the paper by Percy S. Sheardown, with amplifications and variations. 3200 w. Aust Min Stand—Oct. 20, 1904. No. 66379 B.

Shops.

Improvements at the Spencer Shops of the Southern Railway. An illustrated description of the enlargement of locomotive repair shops in North Carolina. 2500 w. R R Gaz—Vol. XXXVII, No. 24. No. 66330.

Keyser Valley Car Shops of the Delaware, Lackawanna & Western. Illustrated detailed description of a large plant, near Scranton, Pa., for repairing cars. 1000 w. Ry Age—Oct. 28, 1904. No. 65860.

New Power House — West Albany Shops. Illustrated description of this new power house and its equipment. It is a part of the plan for modernizing the method of driving. N. Y. C. & H. R. R. R. 1500 w. Am Engr & R R Jour—Nov., 1904. No. 65881 C.

Signals.

A Low-Pressure Pneumatic Interlocking Signal Station (Description d'une Cabine d'Enclenchements à Trajecteurs

Pneumatiques à Basse Pression). E. Despons. Describing experiments on pneumatic signals made by the Northern Railway of France. 7500 w. Rev Gen d Chem de Fer—Oct., 1904. No. 66230 G.

Safety Appliances and Block Signals—Proposed Bill Requiring Use of the Block System. Report of the Committee on Safety Appliances and Block Signals at the Sixteenth Annual Convention of the Nat. Assn. of Ry. Com. at Birmingham, Alabama. 5500 w. Ry Age—Nov. 18, 1904. No. 66158.

Terminals.

Facilities at Railroad Terminals. Albert P. Greenfelder. Discussion at the Int. Engng. Cong. at St. Louis, of the facilities required in large stations, with suggestions for improvements. 2000 w. Ry & Engng Rev—Oct. 29, 1904. No. 65859.

Great Northern Terminal Improvments at Seattle. Illustrates and describes improvements found necessary, including the construction of a tunnel under the business district. 2000 w. R R Gaz—Vol. XXXVII, No. 21. No. 65917.

New Yards and Terminal Approaches at Washington, D. C. W. F. Strouse. Illustrates and describes the new yards and terminal facilities, the bridges which carry the tracks over the streets, retaining walls, etc. 3300 w. R R Gaz—Vol. XXXVII, No. 22. No. 66006.

The Steel Construction in the Wabash Terminal at Pittsburg. Illustrated detailed description of the construction of the Wabash trainshed. 1800 w. Eng Rec—Nov. 12, 1904. No. 66030.

The Washington Terminal Improvement. W. F. Strouse. An illustrated general description of the Union Station and the elimination of grade crossings in Washington. 7200 w. Eng Rec—Nov. 5, 1904. No. 65946.

The Washington Terminal Improvements of the Baltimore & Ohio and the Pennsylvania Railways. W. F. Strouse. An illustrated article describing the work of eliminating grade crossing, the terminal stations, etc. 6000 w. Eng News—Nov. 10, 1904. No. 65998.

Tidewater Terminal of the Western Maryland at Baltimore. An illustrated description of the new terminal at Port Covington. 1000 w. R R Gaz—Vol. XXXVII, No. 23. No. 66159.

MISCELLANY.

Light Railways.

On the Question of the Direct Financial Co-operation by the State and by Localities Interested in the Development of Light Railways (Subject XVIII for Discussion at the Seventh Session of the Railway Congress). C. Colson. Statement of the results obtained in Belgium, France, Germany and the United Kingdom. 23400 w. Bul Int Ry Cong—Oct., 1904. No. 66179 E.

Purchase.

The Ontario & Western Transfer. Editorial, explaining the situation that led to the purchase of this road by the New York, New Haven & Hartford. 1200 w. R R Gaz—Vol. XXXVII, No. 21. No. 65916.

Research Bureau.

Proposed Central Technical Research Bureau for the Austrian Railways. Dr. Wilhelm Exner. Lecture to the Austrian Soc. of Engrs. and Archts. Translated from *Zeitschrift des Oesterreichischen Ing. und Arch. Ver.* A statement of the proposal and arguments favoring it. 9200 w. Bul Int Ry Cong—Oct., 1904. No. 66180 E.

Tunnels.

See Civil Engineering Construction.

TRAFFIC.

Freight.

Comparative Cost of Fast and Slow Freight Service. W. B. Poland. A report of data collected during the months of Jan. and Feb., 1904, and conclusions. 1200 w. Ry Age—Nov. 25, 1904. No. 66316.

India.

Passenger Traffic on Indian Railways. Concerning traffic where the average number of passengers in a train is greater than in any other country. 1500 w. Engr, Lond—Nov. 18, 1904. No. 66393 A.

Suburban.

On the Question of the Suburban Traffic (Subject XII for Discussion at the Seventh Session of the Railway Congress). A. W. Sullivan. Summary of information in response to a circular of inquiry. 4 tables and figures, with 46 photographs. 9900 w. Bul Int Ry Cong—Oct., 1904. No. 66177 E.

STREET AND ELECTRIC RAILWAYS

Air-Brakes.

Energy Required in Watt Hours When Braking with Air. Frank B. Rae. Urging the equipment of cars with air-brakes, and giving information concerning the determination of the proper size, application, cost, etc. 2500 w. St Ry Jour—Nov. 5, 1904. No. 65944 C.

Altered Cars.

Converting Summer to Winter Cars in Cleveland. Illustrated description of the alterations made. 1000 w. St Ry Jour—Nov. 19, 1904. No. 66183 C.

Cable Railroad.

The Mürren Cable Railroad in the Swiss Alps. Brief description of the road connecting Lauterbrunnen and Mürren. 1000 w. Sci Am—Nov. 12, 1904. No. 66009.

Cars.

Double Deck Cars with Covered Tops. An illustrated review of current British practice. 4400 w. St Ry Rev—Nov. 20, 1904. No. 66321 C.

Discussion.

Discussion at St. Louis, Sept. 14, 1904, on "Different Methods and Systems of Using Alternating Current in Electric Railway Motors." 10,600 w. Trans Am Inst of Elec Engrs—Nov., 1904. No. 66091 D.

Electric Locomotives.

See Railway Engineering, Motive Power and Equipment.

Electrification.

Electrification of Railways. A statement showing the great increase in tramway passengers carried in the United Kingdom since the introduction of electricity, with a comparison of the positions of the railways and tramways, and conclusions. 1700 w. Elec Rev, Lond—Oct. 28, 1904. No. 65978 A.

Express Business.

Freight and Express Business of the Interurban Railway & Terminal Co. An illustrated article giving an account of the development of this business in Cincinnati and vicinity. 5000 w. St Ry Rev—Oct. 20, 1904. No. 65892 C.

Gear Ratio.

The Effect of Changing the Gear Ratio on a Series Railway Motor Equipment. J. C. Huffman. Considers a practical case, and concludes that the best gear ratio to use on a given equipment for a given schedule speed is the lowest gearing that with a fair margin will maintain the specified schedule. 1700 w. St Ry Jour—Oct. 29, 1904. No. 65864 C.

German Practice.

Changes in German Electric Railway Practice During the Past Year. A review of changes in construction, equipment and methods, and related matters of interest. 3800 w. St Ry Jour—Nov. 5, 1904. No. 65943 C.

Illinois.

Sterling, Dixon & Eastern Electric Railway. Illustrated description of this line along the Rock River, in Illinois. 2500 w. St Ry Rev—Nov. 20, 1904. No. 66318 C.

Interurban.

The Westinghouse Single-Phase A. C. Railway System for Interurban Service. Brief, illustrated description of the system of control and wiring as used at present. 2400 w. St Ry Jour—Nov. 5, 1904. No. 65945 C.

Lubrication.

Lubrication of Street Railway Motors. W. H. Pope. Remarks on the growing practice of using oil instead of grease, with illustrated descriptions of some of the oil cups used and statistics. 1800 w. St Ry Jour—Nov. 12, 1904. No. 66023 C.

Mountain Road.

Electric Railway with Central Friction Rail (Tramway Electrique avec Mècanisme d'Adherence à Roues Horizontale et Rail Central). A. Dumas. Describing the railway at La Bourboule, Puy de Dôme, France, using the Fell system of a central double-head rail gripped between the horizontal driving wheels. 1500 w. 1 plate. Gènie Civil—Oct. 22, 1904. No. 66212 D.

N. Y. Subway.

The New York Subway Under the East River. An illustrated description of this part of the work, the methods of construction, and general information of interest. 700 w. Ir Age—Nov. 10, 1904. No. 65991.

Noise.

Concerning Noise in the Operation of Elevated Railways. Describes the plan of J. B. Strauss for reducing the noise on the elevated lines of Chicago, with comments. 2500 w. Eng News—Nov. 17, 1904. No. 66133.

Operation.

The Operation of a Four-Motor Equipment with a Two-Motor Controller. Edward Taylor. Gives a detailed analysis of the conditions of such operation, explaining the causes of troubles. 1200 w. St Ry Jour—Nov. 12, 1904. No. 66022 C.

Paris.

Traction Systems of Paris. Paul Dubois. Brief, illustrated descriptions of some of the systems employed. The lines are controlled by many different companies, each using its own method. 3500 w. Elec Wld & Engr—Nov. 26, 1904. No. 66374.

Pipe Work.

Piping and Power Station Systems. William L. Morris. This chapter deals with improper piping, explaining the necessity of better systems, and suggesting methods of securing better work. Ills. 5000 w. St Ry Rev—Nov. 20, 1904. No. 66320 C.

Schedules.

The Determination of Schedules by Speed Templates. Howard S. Knowlton. Shows how the speed template may be prepared and utilized in the solution of schedule problems upon electric railways. 2800 w. St Ry Rev—Oct. 20, 1904. No. 65893 C.

Shops.

New Car House and Repair Shop at Dubuque, Iowa. Illustrated description of the arrangements for the proper maintenance of a large equipment. 2500 w. St Ry Jour—Nov. 12, 1904. No. 66021 C.

Signals.

The Signal and Telephone System on the Cable Section of the Mendel Railway (Die Signal und Telephoneinrichtung auf der Drahtseilstrecke der Mendelbahn). Karl Jordan. Describing the working methods employed on a cable incline in the Tyrol. 1800 w. Zeitschr f Elektrotechnik—Oct. 30, 1904. No. 66246 D.

The Signal System on the Subway Division, Interborough Rapid Transit Co., New York. An illustrated description of the electro-pneumatic block and interlocking system as modified to meet the severe conditions of heavy traffic on an electric railway where the rails are used for the return circuit. 3000 w. Eng Rec—Nov. 12, 1904. No. 66027.

Single Phase.

Single-Phase Electric Railway Work in Europe. A summary of the remarks of C. O. Mailloux on some investigations he had made in Europe on alternating-current railway work, contributed in the discussion of the paper by Prof. A. S. McAllister. Ills. 6600 w. St Ry Jour—Nov. 26, 1904. No. 66372 C.

Stray Currents.

See Civil Engineering, Water Supply.

Switzerland.

The St. Gall-Speicher-Trogen Electric Railway. S. Herzog. Illustrated detailed description of a recently constructed railway driven by direct current obtained through transformers and converters from the three-phase 10,000-volt supply coming from the Kubelwerk. 2000 w. St Ry Rev—Nov. 20, 1904. No. 66319 C.

Terminal Building.

Indianapolis Traction Terminal Building. Illustrated description of a recently completed building, said to be the most modern and complete electric terminal railway station in the world. 1000 w. St Ry Jour—Nov. 12, 1904. No. 66020 C.

Test Car.

The Autographic Test Car. Albert B. Herrick. Illustrated description of a car for testing and making defective bonds automatically, and also providing a complete record of the electrical condition of the return circuit. 2000 w. St Ry Jour—Nov. 26, 1904. No. 66371 C.

Tokio.

The Tokio Metropolitan Railway. Describes in detail a new line, wholly in bank or viaduct, through the heart of the city. Ills. 2500 w. Engng—Nov. 11, 1904. No. 66197 A.

Tracks.

Notes on Permanent Way for Tramways. A. N. Connett. An analysis of proportionate costs, with discussion of construction details. 5000 w. Elect'n, Lond—Nov. 4, 1904. No. 66044 A.

Traction Resistance.

Tractive Force and Grade Reduction in Street Curves (Zugkraft und Neigungsreduktion in Strassenkurven). K. Nussbaumer. A mathematical investigation of the relations between curve and grade resistances on street railways. 2000 w. Schweizerische Bauzeitung—Nov. 5, 1904. No. 66228 B.

Tramway Economics.

The Economics of Electric Tramways in Britain. Robert H. Smith. Tabulated statistics and general information of a number of British lines. 3000 w. Engr, Lond—Nov. 11, 1904. No. 66302 A.

Tramways.

Leeds, Wakefield and West Riding Tramways. Illustrates and describes an extensive system of electric tramways in England. 2000 w. Elec Engr, Lond—Nov. 11, 1904. No. 66193 A.

Permanent Way for Tramways. Charles T. Taylor. Read before the Rugby Engng Soc. Discusses rails, special work, foundation, paving, etc. Ills. 5000 w. Mech Engr—Nov. 19, 1904. No. 66354 A.

Troubles.

Some Power Plant Experiences. H. C. Reagan. A review of difficulties and accidents in an interurban power station near New York. 1800 w. St Ry Rev—Nov. 20, 1904. No. 66322 C.

Underground.

New York's Great Underground Railway. An illustrated article giving the history of the undertaking, the route, construction, track, stations, lighting, rolling stock, signaling, etc. 11400 w. Tram & Ry Wld—Nov. 10, 1904. No. 66355 B.

See Also Electrical Engineering, Motors.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*. a semi-weekly, *m*. a monthly, *b-m*, a bi-monthly, *t-m*. a tri-monthly, *qr*. a quarterly, *s-q*. semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *w* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Public Works. *m.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

THE
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THE REVIVAL OF DE LESSEPS' SEA-LEVEL PLAN FOR THE PANAMA CANAL.

By Gen. H. L. Abbot, with an Editorial Introduction.

THE world has a right to demand from the United States, and the American public to require of any Commission charged with the construction of the Isthmian Canal, two things. First, the immediate and diligent prosecution of all work which will certainly contribute to the successful completion and operation of the waterway, whatever plan may be finally adopted; second, the most enlightened wisdom in the selection of the final plans, and the completion, in the shortest practicable time, of the canal most serviceable to the commerce of the world.

The former is chiefly a matter of engineering organization, and the efficiency already developed in the field work and other operations on the Isthmus was well reflected in the outline presented in these pages last month by Professor Burr, and is even more fully developed in the very valuable summary of the work now going on upon the Isthmus, and the proposed methods for prosecuting the construction of the canal, with which Mr. Grunsky, another member of the Commission, closes the leading pages of this number.

The latter and larger matter to be determined by the Commission is primarily the solution of a group of great problems in hydraulic engineering, to which the best studies of specialists intimately familiar with the data and conditions will lend invaluable aid. The Commission would ill administer their trust if they did not realize this and devote the needed time and thought to it. There is no need to urge that General Abbot's qualifications rank him very high among those whose counsel should be heeded, and we are glad to be the medium of his communications.—[THE EDITORS.

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THE advocates of the prompt construction of the best possible canal, now that we have secured what is well-known to be the best possible route, cannot but feel disappointed at the progress of events. We were first told by the daily press, some months ago, that it is necessary to begin examinations *de novo,* including surveys and all other details of the project, as nothing had been learned with sufficient accuracy to form the basis of a satisfactory American plan.

To say the least this was surprising. Much time and many millions of dollars had been devoted to the work of investigation by the New Canal Company, and in the opinion of competent engineers the data collected left little to be desired. Our Isthmian Canal Commission of 1899-01, after studies covering two and a half years, had expressed their opinion in the following language:

"The information relating to the topography, hydrography, and geology of the Isthmus is now much more complete than is usual before the inauguration of an engineering enterprise in a new country. The Canal Company spared no trouble or expense in laying it all before the Commission. The most important maps, drawings, and documents were lithographed or printed, and systematically arranged for the use of the Commission, copies being furnished for each member. Many other documents were supplied in manuscript. In all some 340 documents, many of them elaborate studies, were furnished. A list of them will be found in Appendix C. These supplied essentially all the data required for the preparation of plans and estimates though further information was desired as to the foundation upon which the great dam at Bohio must be built, and as to the area of the Chagres River drainage basin. This additional information was obtained by the field parties of this Commission. It was necessary also for the purpose of this investigation to verify the French data. Independent lines of levels, measurements of distances, borings, soundings, and hydrographic observations made by its own parties, supplemented by personal observation, enable this Commission to state that the data furnished by the Canal Company are essentially correct."

Confronted by this official statement, the early rumors were naturally attributed to the lack of knowledge of the authors. No well informed person can fail to recognize that the final plan requires time for the closest technical study, but it is equally true that a large force can be set at work at once without fear of future changes in plan causing loss. The excavations at the continental divide can be pressed with energy. In this connection it may be stated that experience has taught that the real problem at the Culebra lies not so much in the development of the extreme efficiency of the dredging machines as in securing the utmost rapidity of transporting the material to the dumps, which are a mile or two away. The necessary continual shifting of tracks, often under heavy rainfall, causes frequent derailments. If the steam engines—the heaviest vehicles of the trains—could be replaced by electric traction, the practical gain would be great. The construction of the dam at Alhajuela would enable this to be done. The surveys for the location of the branch railroad, 10 miles in length, and the plans for the masonry dam, which offers no serious problem, are completed, and were turned over to the Commission, and a large force could at once be put at work. If any element of the problem of the best possible canal is settled it is the necessity for this dam. It is needed for the regulation of the floods and freshets of the Chagres, and for the storage of the low-water supply when the canal is in operation; and it would be of immense service in controlling rises of the river during the construction of the Bohio dam, and in supplying electrically transported power for illumination and traction at the Culebra and elsewhere. The sooner it is completed the better for the progress of the canal construction.

But, of late, new rumors, this time from the Isthmus, are rife in the daily papers. The site for the dam at Bohio, although it has been approved by nearly every engineer who has studied the subject, is found to be unfit for the purpose. The site at Gamboa, although rejected again and again as unsafe, by competent engineers, is found to be favorable. Finally, the ancient sea-level plan of which M. de Lesseps was the father, and which brought ruin to his company, is again to be raised from the dead and seriously considered. So, at least, say the current reports. It is hardly necessary to add that they are without any actual foundation in the official reports or announcements of the Commission; but they are important in that they tend to mislead public opinion and throw the weight of popular demand on the wrong side of the case. It would be the irony of fate, if, after emerging from the clouds of obliquy under which his name has rested for so many years, M. de Lesseps should be recognized as the father of the American plan. Fortunately the new Commission has as yet given no sign of favoring the project, and as the responsibility of determining the plan rests upon it, and ultimately upon Congress, which alone can authorize so great an increase of the estimated cost and so great an extension of the estimated time, it is to be hoped that those who are counting on an early opening of the canal to the commercial needs of the country may not be disappointed.

The dream of M. de Lesseps was a canal without locks, but he was a diplomatist, not an engineer by profession; and indeed, the information then existing was wholly insufficient to justify any technical opinion on the matter. The Isthmian Canal Commission of 1899-01 definitely rejected the idea, stating: "The cost of such a canal, including a dam at Alhajuela and a tide lock at Miraflores, near the Pacific end, is estimated at not less than $240,000,000. Its construction would probably take at least twenty years. This Commission concurs with the various French Commissions which have preceded it since the failure of the old company, in rejecting the sea-level plan. While such a plan would be physically practicable, and might be adopted if no other solution were available, the difficulties of all kinds, and especially those of time and cost, would be so great that a canal with a summit level reached by locks is preferred."

It seems to be not without utility to elaborate more fully these other difficulties. The real object in view is the construction of the best possible canal when completed and opened to traffic. It may be remarked at the outset that a construction wholly without locks is impracticable at any expense, since the tidal oscillation of the Pacific, about 20 feet, can be controlled only by a lock near Miraflores. One lock being a necessity, the addition of four others becomes less objectionable. Furthermore, modern improvements in construction, since the time of M. de Lesseps, have worked a great change in opinion as to the difficulties they entail. On the Sault Sainte Marie Canal with its unequalled traffic, the Manchester Ship Canal, the Kiel Canal, and the Amsterdam Canal, they are in constant use, and are everywhere regarded as much less objectionable than are curves of short radius, because when the wind blows from the side or from the rear the latter offer far more serious impediments to navigation. It is true that locks cause slight delays; but when, as at Panama, the entire transit can be accomplished in a single day without encroaching upon the hours of darkness, this is a minor consideration. If locks are to be avoided only by introducing greater dangers and difficulties, it certainly is the part of wisdom to admit the locks. The true criterion is ease and safety of transit, and that this test leaves no doubt as to which type of canal should be preferred at Panama appears from the following review of the local conditions.

Near Gamboa, where the Chagres first joins the route of the canal, the bed of the river is about 45 feet above mean tide level, and since below that point the old bed (now occupied by the canal) followed the lowest depression in the valley, any new banks must dominate the latter for several miles. In other words, the water would naturally pour into a sea-level canal in the form of a huge cascade. Hence there are only three possible solutions of a sea-level canal with one lock:—

(1) The plan adopted by the old Company was to excavate a new bed for the stream from Gamboa to the Atlantic coast. The opening of such a channel would demand not only enormous excavations, but also the construction of very high levees for several miles where the stream must dominate the canal. But such levees confining a river having so torrential a regimen could not but be a standing menace. It needs only to imagine a ship canal constructed parallel to and behind the levees of the Mississippi, to estimate the slight attractions such a canal would offer to mariners. Even with an upper lake to control more or less the floods of the Chagres, a canal having such a neighbor would be much less safe than a canal with locks judiciously planned, and hence would be distinctly inferior.

(2) Another solution would be to make the canal prism so large that, aided by an upper lake for partial regulation, it could carry the volume of the river. The advocates of this plan have not explained how they propose to deal with the natural cascade exceeding 45 feet in height at Gamboa, in order to admit the water to the canal. Thence to Alhajuela the natural bed of the Chagres rises four or five feet to the mile, and any grading would cause velocities too great to be seriously considered. But even admitting some solution of this problem of how to conduct the flow into the canal made large enough to carry the volume, the resultant current, always liable to considerable fluctuations, could not but interfere with easy and safe transit, as do curves. A canal with locks, judiciously planned, would be subject to no such drawback.

(3) A sensibly total diversion of the upper river, either to the Atlantic or to the Pacific, has been suggested as a third solution. Strictly speaking, this should provide for intercepting and diverting the run-off from the whole watershed of the Chagres above Bohio. But only about half of the flow at Bohio passes Alhajuela, and even at Gamboa, where the Chagres meets the line of the canal, it carries but 79 per cent. of the flow passing Bohio. This plan for diversion of the upper stream, therefore, would involve the abandonment of an excellent site for an upper dam at Alhajuela, and compel the construction of a dam at or near Gamboa, where the site is far from favorable. Furthermore, to convey away so large a volume—which might equal 65,000 cubic feet per second for a period of 48 hours—tunnels of large section must be driven for miles through materials which can only be made certainly known by trial drifts of equal

length; and this in a climate where the average daily temperature is 80° F. Moreover, the dam site at Gamboa, after careful examination, has been found to be so unfavorable as to be finally rejected by the engineers of the new company as unfit for a safe dam. It was favored by M. de Lesseps when the logic of events compelled him to abandon his sea-level project, but no detailed study and no works were ever attempted by him. But even granting that this third proposed solution is feasible from an engineering point of view, the canal would still be inferior to one with locks judiciously planned. The numerous tributaries of the Chagres between Gamboa and Bohio —that is, below the proposed diversion of the main stream—carry considerable volumes, fed by a rainfall greater than on any other part of the canal route. Entering laterally, these contributions would cause cross currents and eddies in the route for shipping never to be encountered in a really good canal. Furthermore, the Chagres, transformed from a useful friend into an enemy lying in wait behind the Gamboa dam, would threaten destruction in case of a failure like that of Johnstown, or serious delays in transit in case of any yielding in a long tunnel carrying rapid currents, where repairs would be excessively difficult. Is it safe to trust to a construction condemned by so many competent hydraulic engineers?

In fine, it is the unanimous opinion of all the engineers who have had practical experience in canal work, and time to study the problem thoroughly, that no sea-level project without locks, and no sea-level canal with a tidal lock, is practicable, that would be comparable in ease and safety of transit to one equipped with modern locks and planned to take advantage of all the desirable elements which the natural conditions offer. Why then waste an extra ten or a dozen years and untold millions of dollars, to execute a scheme which the investigations of thirty-five years have demonstrated to possess only a sentimental merit due to the imagination of M. de Lesseps? Congress and the American people are impatient for the opening of the best possible canal, and this involves well planned modern locks. The gates of those recently constructed at the sea entrance to the Amsterdam canal are operated electrically, and by a single man. At the Sault Ste. Marie canal, over thirty million freight tons have passed in a single year, although for some months it was closed by ice. The old prejudice against locks is rapidly passing away among hydraulic engineers conversant with modern progress. The Panama canal is an hydraulic problem, and should be planned in accordance with the dictates of modern science.

HYDRO-ELECTRIC POWER PLANTS IN THE CANADIAN NIAGARA DISTRICT.

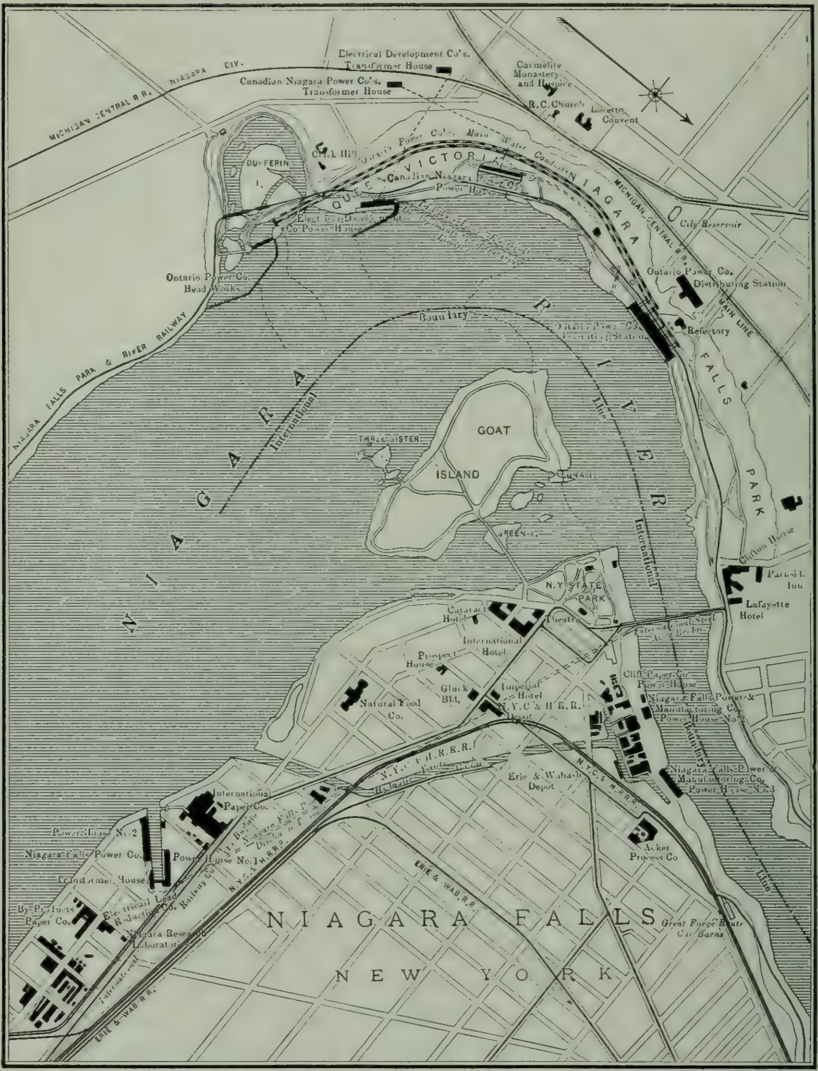
By Cecil B. Smith.

Mr. Smith was in charge of construction of the Canadian Niagara Power Company's plant from its commencement, some three and one-half years ago, until very recently, the first two units of this plant having been placed in operation on Jan. 1, 1905. He is therefore most intimately familiar with the entire scheme of development of the Niagara water power, and this knowledge is reflected in the very clear and comprehensive survey of the Canadian projects which follows.—The Editors.

"Force rules the world still,
Has ruled it—shall rule it."

WHAT this subtle thing is—so elusive and yet so powerful, so obedient and yet so deadly—I leave it to the knowing ones to tell you; but to the everyday engineer who has been for years busy at his task, sowing that others may reap, with his sense of achievement as his chief reward, electricity appeals as being a new and very pliable vehicle by which energy may be applied to various uses. Even among the many great achievements of the Nineteenth Century, the development of power ranks as one of the greatest from the point of view of an engineer; and although we have become so familiar with steam power that it scarcely receives that respect which it still deserves, this younger child commands homage, care, and admiring attention.

After the success of the Frankfurt experiments it became evident that long-distance transmission was the means by which a much wider scope could be given to this new force, and events have justified that belief to as full an extent in Canada as in any country in the world. The configuration of this country with its many rivers, flowing often down considerable declivities; a lack of coal near the greater centres of population; and the enterprise of its people—all have combined to make Canada rank second only to the United States in the development of hydro-electric power. It has now, according to Government statistics, 228,000 horse power of water power engaged in the production of electricity, representing over one-tenth of the world's total, and, by present indications, while a large amount of our water power is sure to be devoted to pulp


Electrical Development Co's. Transformer House
Canadian Niagara Power Co's. Transformer House
Carmelite Monastery and Hospice
R.C. Church
Loretto Convent
MICHIGAN CENTRAL R.R.
NIAGARA DIV.
DUFFERIN I.
Cedar Hill
Ontario Power Co's. Main Water Conduit
QUEEN VICTORIA PARK
Canadian Niagara Power Co's. Power House
Electrical Development Co. Power House
Ontario Power Co. Head Works
NIAGARA FALLS PARK & RIVER RAILWAY
City Reservoir
Ontario Power Co. Distributing Station
MAIN LINE
Refectory
Ontario Power Co's. Generating Station
Boundary
International
Line
NIAGARA RIVER
FALLS PARK
GOAT ISLAND
THREE SISTER
LUNA I.
GREEN I.
Clifton House
Parrish Inn
Lafayette Hotel
N.Y. STATE PARK
Cataract Hotel
Theatre
International Steel Arch Bridge
International Hotel
Prospect House
Gluck Bld.
Imperial Hotel
N.Y.C & H.R.R. Depot
Natural Food Co.
Cliff Paper Co. Power House
Niagara Falls Power & Manufacturing Co. Power House No. 2
Niagara Falls Power & Manufacturing Co. Power House No. 3
N.Y.C & H.R.R.
Erie & Wabash Depot
N.Y.C & H.R.R.
International Paper Co.
Power House No. 2
Niagara Falls Power Co.
Power House No. 1
Transformer House
Niagara Falls Power Co. Discharge Tunnel
N.Y.C & H.R.R.
Buffalo Railway Co.
ERIE & WAB. R.R.
Acker Process Co
By-Products Paper Co.
Electrical Lead Reducing Co.
Niagara Research Laboratories
International
NIAGARA FALLS
NEW YORK
Great Gorge Route Car Barns
ERIE & WAB. R.R.

MAP SHOWING ELECTRIC-POWER DEVELOPMENTS AT NIAGARA FALLS.

Scale approximately 2 inches to 1 mile.

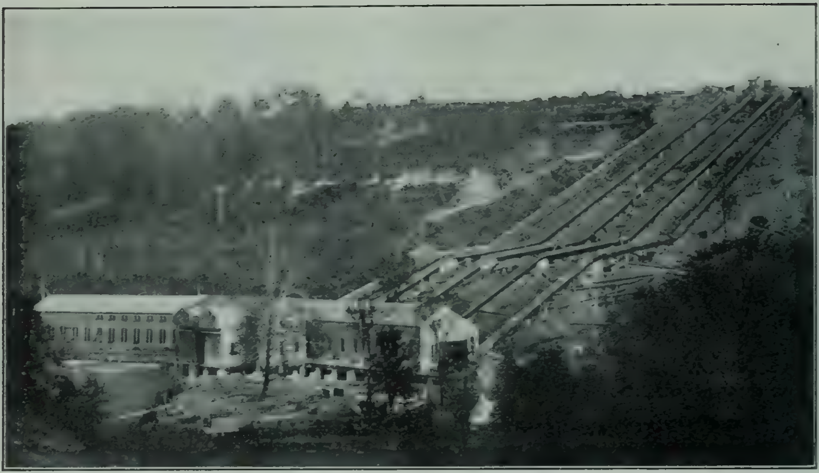
grinding, the varied demands for electrical power justify capitalists in an immediate increase in investment in water-power plants built to produce electricity.

The Niagara district presents unusually favorable conditions for hydro-electric development, such as certainty of water with slight fluctuations in head, vigorous and varied markets, and reasonable freedom from ice troubles. Lake Erie is a big millpond which varies only slightly from day to day and season to season; so that if we even include the effect of the Chicago drainage canal's future increased draft, and Dr. J. W. Spencer's nerve-shaking statement that Chicago is lowering relatively to Niagara at the rate of 1½ feet per century, we may rest easy in the assurance that for two or three centuries at least there will be water to "burn."

While there are no large cities on the Canadian border at Niagara, the total population of southwestern Ontario within 125 miles of Niagara Falls is about 1,500,000 and, besides a great number of small manufacturing towns, includes Toronto (250,000), Hamilton (60,000), London (50,000), Brantford (20,000), St. Catharines (12,000), Stratford (12,000), Guelph (13,000), St. Thomas (12,000), Berlin (10,000), and others. Electric urban and interurban roads are steadily increasing. A great number of United States firms, such as the International Harvester Company and the Westinghouse Electric & Manufacturing Company, are building large Canadian works, and we may confidently look for 150,000 horse power being taken care of in one way and another as fast as it can be put on the market, in addition to which a large amount will be exported to help out the present plants on the United States side.

The difficulties with ice are largely matters of prophecy, as even those small plants already in operation are changing their conditions at the present time; but, roughly speaking, we may divide the plants into two classes—those drawing from large reservoirs, not subject to frazil or anchor ice, and those drawing from the rapids of the Niagara River and thus subject to frazil ice, anchor ice, and heavy drift ice in detached masses and in large floes. The special conditions of each plant will be touched on in connection with detailed information regarding these plants.

(A) Welland Canal Power Plants.—During the past fifteen years the *old* Welland has been practically closed to vessel traffic, and the Dominion Government has leased to various users limited quantities of water on each level, in addition to that already so used while the canal was in operation for vessel traffic, and in this way a large number of small stations have been equipped with ordinary stock turbines operating under 12-feet to 14-feet head, the power so produced being used for pulp grinding, flour mills, paper mills, calcium-carbide manufacture, electric light and power, and in other various important manufactures.



ENERATING STATION OF THE HAMILTON CATARACT POWER, LIGHT, & TRACTION CO., LTD., POWER GLEN, ONT.

The illustration shows the present development of the De Cew Falls plant. The original development consisted of the left-hand wing only of the building now shown, and a single penstock—the one farthest to the left in the picture.

In this manner some 10,000 horse power has been developed. As there are no rapids in which frazil or anchor ice can be formed, and as the slow current in the canal allows it to freeze over early in the winter, very little trouble is met with in operating through the winter season, except near St. Catharines where an hydraulic raceway of small dimensions and high water speed gets blocked by the excessive rise and fall in its water levels.

The De Cew Falls plant, about to be described, also draws its water from the Welland Canal.

(B) Hamilton Cataract Power, Light & Traction Company's Plant at De Cew Falls.—In 1895 the commercial operation of three 5,000-horse-power units at Niagara Falls Power Company's Power House No. 1 suggested to certain enterprising citizens of Hamilton, Ontario, the delivery of electric power into that city, and, negotiations with these and other parties having failed, a company was formed, water rights were obtained from the Dominion Government, and the construction of a plant drawing its water from the old Welland Canal at Allanburg was commenced. The installation was carried out by a headrace canal nearly five miles in length, a steel pipe down the escarpment with total head of 267 feet, supplying water to various horizontal units, and a natural tailrace leading to Lake Ontario.

Progressive equipment has been as follows: In 1897 a development of four 1,000-kilowatt units was prepared for and two of them were put in operation, the variation in water consumption being taken care of by large storage ponds at the brow of the escarpment. Later on the turbines, which had been installed by a well-known United States firm, were found defective and the plant was remodelled by installing two 2,100-kilowatt wheels made by A. Riva, Monneret & Co., Milan, Italy, operating at 286 revolutions, and by replacing the original two 1,000-kilowatt wheels by new wheels of Swiss design made by the same United States firm, thus giving a station of 6,000 kilowatts which has been in successful operation up to the present time and making current which has been taken to Hamilton (32 miles) at 22,000 volts (now changed to three-phase, 66 2/3 cycle, 40,000-volt transmission) and devoted to general use, including electric lighting, urban and interurban railways, cotton mills, knitting mills, flour mills, machine shops, foundries, rolling mills, etc., and as demands continued to exceed the supply, and many towns and villages in the vicinity had also to be taken care of, it was decided in 1903 to enter upon a second and more ambitious stage of development.

Additional water rights were obtained and a large canal excavated. The riparian rights in the Beaver Dam valley were taken over from the city of St. Catharines in exchange for a purer supply of water from Lake Erie, and reservoirs of 500-acres area and 10 to 40 feet in depth created. The added equipment when complete will consist of seven steel penstocks down the escarpment and a generating station of two 5,000-kilowatt and four 6,500-kilowatt units; and of these, four penstocks are now built, a generating station for four units built, and two 5,000-kilowatt units now in commercial operation. Each of the two present units consists of a horizontal spiral-case turbine operating under 267-feet head at 286 revolutions, made by J. M. Voith of Heidenheim, Germany, and discharging by two concrete draft tubes, direct connected to a 5,000-kilowatt horizontal alternator made by the Westinghouse Electric and Manufacturing Company and delivering three-phase, 66 2/3 cycle, 2,400-volt current.

We thus have a plant of a present capacity of 16,000 kilowatts, capable of being increased to 29,000 kilowatts by the addition of two machinery units and to 42,000 kilowatts (10 hour) by a moderate expenditure, and by reason of its large pondage area it is immune from ice troubles, can carry an overload quite easily, and even afford

CANADIAN POWER PLANT, INTERNATIONAL RAILWAY CO.

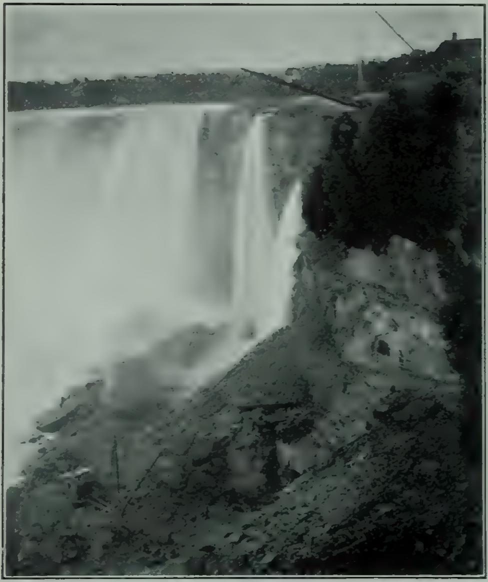
The upper view shows the entrance canal and the ice rack; the lower, the forebay and power house.

to have its supply cut off for short periods. It is a cheap installation without any pretense in respect to appearance, but with every effort to obtain first-class equipment; and operating under a good head, within easy reach of a growing market, it may be looked on as a strictly business proposition and a money maker.

(C) International Railway Company's Plant at Niagara Falls, Ontario.—In 1892 The Niagara Falls Park and River Railway Company built a power house to operate their line from Queenston to Chippewa (11 miles) and, after excavating a small headrace and wheelpit and a tunnel, installed two 1,000-horse-power vertical turbine units, operating under 55 feet, made by William Kennedy and Sons, Owen Sound, Ontario. These were 45-inch new American downward-discharge wheels with wicket gate and single draft tubes. The shafts pass up through the centres of penstocks, and drive a countershaft to which were belted three 200-kilowatt 500-volt direct-current generators making current for railway purposes, and a few years later two 450-kilowatt 2,200-volt alternators for the temporary use of the Canadian Niagara Power Company.

This plant operated under considerable difficulties from ice, in spite of a large ice chute to wheelpit, because of its small headrace capacity and the high speed of approach, until 1903 when a remodeling of the plant was decided upon and at once commenced. The headrace was then made ample for 8,000 horse power, an ice rack added, forebay room extended, and old wheels repaired, also having their draft tubes lengthened and one of them being changed to a cylinder gate in order to control it by an automatic governor. The tailrace tunnel was enlarged and wheelpit extended sufficiently for placing one 2,000-horse-power, vertical, direct-connected unit which is now being installed by the Jenckes Machine Company, Sherbrooke, Quebec. This unit is a 60-inch inward and downward discharge single Francis turbine, and will operate under 60-feet head with a water balancing piston and high-pressure oil at thrust bearing and will be fully equipped with oiling and water-cooling systems.

The new generator is a General Electric 1,500-kilowatt direct-current 575-volt machine operating at 175 revolutions, and will work in conjunction with at least six 200-kilowatt belted machines and a bipolar booster (for Queenston service) from old wheels, giving a total immediate output of 2,700 kilowatts. The enlargement has been so carried out, however, that, by removing old wheels and enlarging wheelpit, three additional 1,500-kilowatt units can be installed in the present power house, using the present forebay and tunnel; this would give 6,000-kilowatts output, one-half of which would be for local use and one-half for transmission further east to carry loads in vicinity of LaSalle and Tonawanda, N. Y.



PORTAL OF TUNNEL, CANADIAN NIAGARA POWER COMPANY.

Taken in June, 1902.

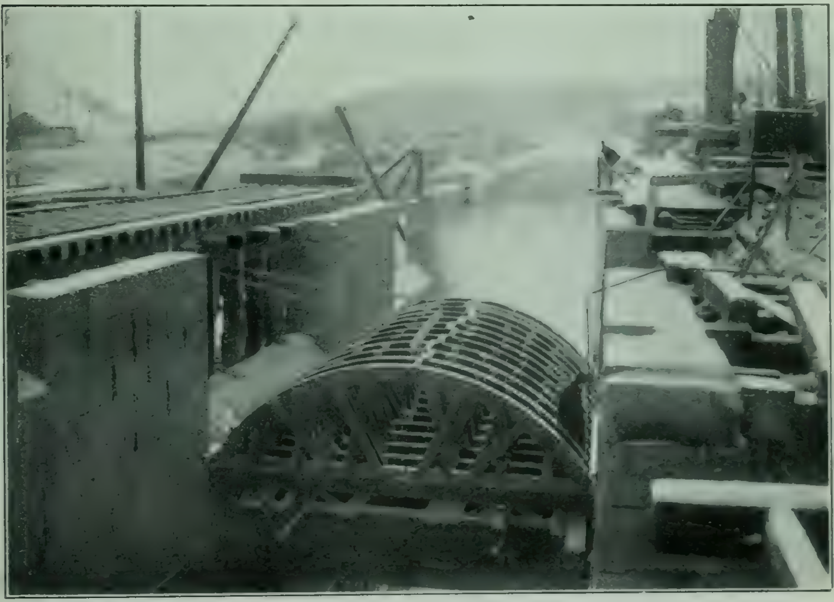
At the river the ice rack has been supplemented by a boiler-plate curtain extending for two or three feet below water level. The head canal has ample capacity and is equipped with floating booms converging to an ice chute at the centre of the forebay, so that serious trouble need not be anticipated from either floating or suspended ice. In any vicinity but Niagara Falls, a water-power development of 6,000 kilowatts would bulk larger and receive more notice than this humble brother of the great dominating power plants of the Niagara district is ever likely to receive.

(D) Canadian Niagara Power Company's Plant.—In 1892 certain parties obtained from the Government and from the commissioners of Queen Victoria Niagara Falls Park a franchise for developing power from the waters of the Niagara River above the Horseshoe Falls. and after futile efforts to float the scheme in England and Canada, where confidence in such a development had not yet been established, turned it over, at a nominal sum, to the Niagara Falls Power Company; but it was not until the spring of 1901 that actual development began. At this time the Ontario Power Company was becoming active and the Niagara Falls Power Company's Power House No. 2 nearing completion.

In outlining the design for this plant, certain evident advances on previous similar installations were decided on which consisted mainly of (1) 10,000-electrical-horse-power generators of internal revolving-field type; (2) consequent shortening of wheelpit, power house, etc. from 80 feet per 10,000-horse-power to 48 feet per 10,000-horse-power; (3) generating voltage three-phase, 25-cycle, 12,000-volts, which enables local long-distance transmission to be made without transforming: (4) revolving parts of unit fully supported by high-pressure oil thrust bearing as a reserve to water-balancing piston support.

The first installation contemplated a completed tailrace tunnel for 110,000 horse power, and this is now finished. It is 25 feet high and 19 feet wide, of an inverted horseshoe section, and is lined with 15 inches of concrete faced with 4 inches of highly burnt shale brick, the arch, however, being entirely of brick. The tunnel has a grade of 7 feet per 1,000, is 2,200 feet long, and empties, one-half submerged, by an ogee curved portal 100 feet long, lined with 2 feet of granite and finishing in a square headwall carried 34 feet below water level. The rock being largely shale, a full timbered arch and plumb posts were required, and excavating was carried on by a full top heading and two benches, arch timbers and wall plates being kept close up to the heading and plumb posts inserted at the time benches were being driven.

In order to construct the canal and forebay, a somewhat extensive cofferdam was placed in the swift and deep water of the Niagara River and, after fulfilling its mission, is now being removed. The design was one of two lines of cribs with an 8-foot puddle space and held together by iron turnbuckles. The puddle—a mixture of gravel and clay—was very effective; but owing to the boulder formation of



WHEELPIT LINING WALLS AND ARCH CENTERS, CANADIAN NIAGARA POWER COMPANY.

the river bed under the cribs, it was considered advisable to carry a water-tight double tongued and grooved sheeting down to rock on the inside and toe it with concrete, which reduced the pumping to nominal proportions and remained absolutely intact for over two years.

The entrance canal and forebay are also built complete for 110,000 horse power and, being spanned by a wide stone arch bridge of graceful design, and contained by rock-faced ashlar walls surmounted by parapets with fine bush faced copings, present a pleasing and yet massive appearance. This basin, under normal conditions, will have 15 feet of water, and with plant in full operation will require a speed of approach of only one foot per second across the forebay, thus encouraging the formation of a surface ice sheet and consequent rising of anchor and frazil ice to the surface. As a first line of defense, an outer ice rack is provided which will take care of those occasional runs of heavy ice which occur after a protracted period of east winds; and a line of submerged arches supporting the forebay room of the power house will tend also to check the progress of that fine slush ice which will pass through the outer rack.

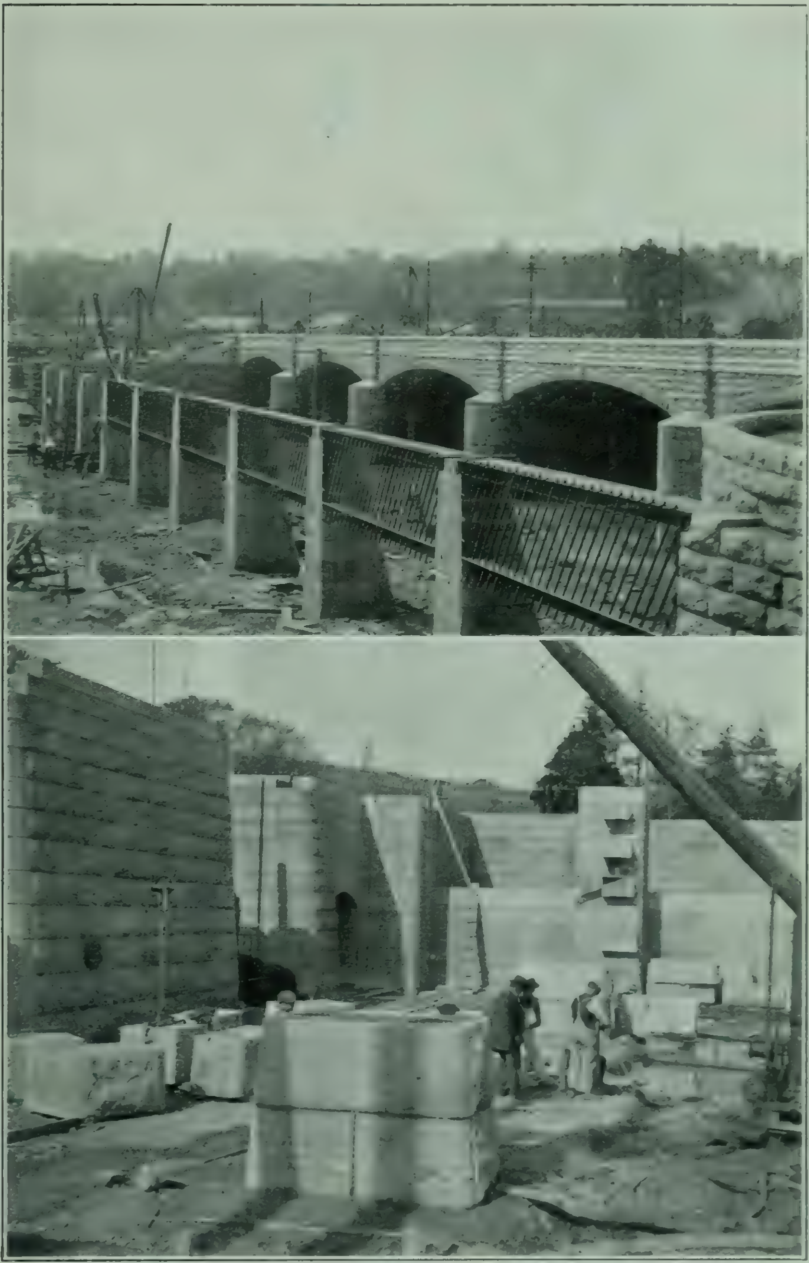
At the down-stream end of the forebay, submerged weirs have been added with a sluiceway returning to the river, and taking advantage of the fall in the river a drop of some two feet is creatable at this point, thus inducing floating materials either inside or outside the forebay room to pass back into the Niagara River.

The entrances to the penstocks are through 18-foot openings in the main breast wall, and cast-iron mouthpieces set in the main pit walls, each entrance being controlled by steel head gates raised and lowered by means of screws and 20-horse-power motors.

Along the face of the breast wall and inside the forebay room a continuous line of fine ice racks is placed, with the centre section removable, so that should ordinary raking not prove effective in caring for weeds, chips, and ice, the latter may be gotten rid of by the *"dernier ressort"* of raising up the racks by means of a forebay crane and letting the wheels take care of it.

The wheelpit for receiving the hydraulic machinery is equivalent to a sky-scraper building, depressed so that its roof is at the ground level. It is 570-feet long, 18-feet wide, and varies from 165 feet to 148 feet in depth, the bottom being on a grade of three feet per hundred toward the tunnel which flows from its lowest point toward the lower Niagara level.

The wheelpit is lined with 15 inches of brick anchored to the



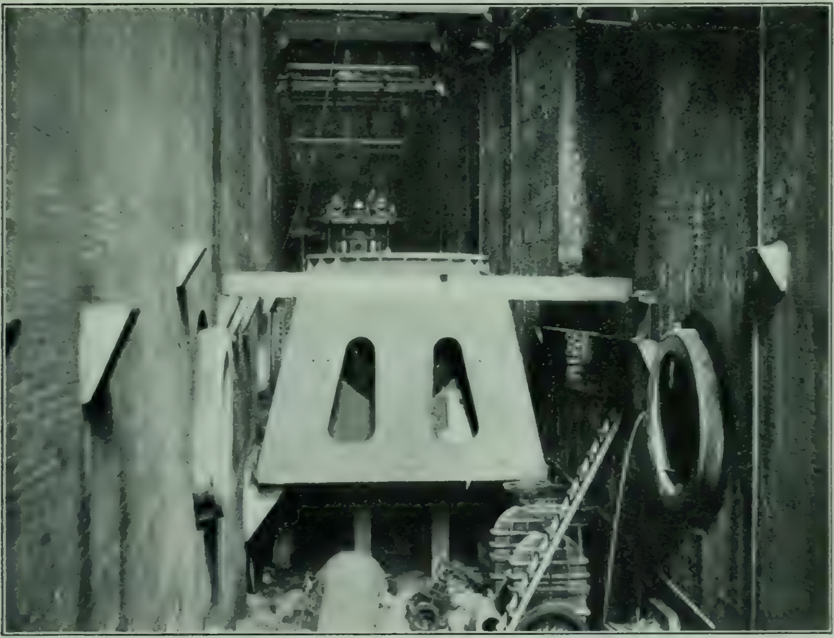
PORTIONS OF THE HEADWORKS, CANADIAN NIAGARA POWER COMPANY.

The upper view shows the outer ice rack and stone arch bridge as it appeared in July, 1904; the lower, taken in the October preceding, shows the inlet, weir, and forebay pier masonry.

POWER HOUSE CONSTRUCTION, CANADIAN NIAGARA POWER COMPANY.

The upper view is taken along the inlets, inner ice rack and forebay; the lower one is a general view of the forebay and power house. Both represent the condition of the work in October last.

solid rock behind, the first course next to the rock being hollow to take care of water leaking in from river; and it is divided into various floors or decks necessary for operation of machinery. There is also a passenger elevator, and two 50-ton cranes traverse the power house surmounting the pit, making possible the installation of the enormous castings, machinery parts, etc., which fill it, while the actual construction of the pit itself, after being channelled, drilled, and blasted, was carried on by two travelling 10-ton hoists working along the edges of the pit.



TURBINE INSTALLATION, UNITS 1, 2, AND 3, CANADIAN NIAGARA POWER COMPANY.

When the Niagara Falls Power Company equipped their first power house they used twin free-discharge wheels, each of 2,500-horse-power capacity, or 5,000 horse power per unit. The next step in advance was made at their second power house, where the wheels are single inward-discharge wheels with draft tubes, of 5,500-horse-power capacity; all of which naturally led to the Canadian Company installing twin inward-discharge vertical Francis wheels of a capacity sufficient to turn out 10,000 electrical horse power under 136-feet effective head, operating at 250 revolutions. These were designed by Escher, Wyss & Company, of Zürich, who are also contractors for three units now commencing operation, and I. P. Morris Company of Philadelphia are installing two units, making 50,000 horse power for the present installation. The current is produced by direct-connected 10,000-electrical-horse-power, three-phase, 25-cycle, 12,000-volt machines with internal revolving fields, made by the General Electric Company, and is controlled by an elevated switchboard located on the main power-house floor and parallel to its length, with corresponding bus-bar compartments in a subway immediately underneath.

Naturally, a power plant of this extent has a large amount of auxiliary machinery, but nothing of this nature mars the sweep of vision in the power house itself; lined with enamel brick, marble, and buff brick, it presents from the visitors' gallery a simple and dignified panorama in keeping with the magnitude of the work. In secluded chambers, however, burrowed into mother Earth from the side of the pit and just above the lowest floor, are found the pulse, nerves, and lungs of the large machines. In one are vertical direct-connected turbo-generators making 1,000 horse power of 125-volt direct current for excitation and for operating cranes; in another, two 3,000,000-gallon horizontal centrifugal pumps, also turbine-driven, are prepared to supply water one-half mile distant to cool the transformers; and in still another are many tanks, filters, and pumps for high and low-pressure oil service, whose mission it is to force through the brass oil-pipe systems the oil necessary for proper operation, and to cool and clarify it on its return. Finally, there is installed at the tunnel exit a huge lift gate sliding in grooves and handled by screws and an 85-horse-power motor. This gives absolute control of the level of the water in the lower reaches of the wheel-pit, no matter how many large units are in operation.

The power-house building is of Queenston limestone and having a tile roof is practically fireproof. It will be considered, by even critical observers, fit for its purpose, substantial and dignified, while the forebay room facing the river, with a tiled promenade roof, affords a viewpoint worthy of Niagara Falls.

For the disposal of power generated, the Park Commissioners require underground conduits to points beyond the Park, and these have been built entirely of concrete and tile, spaced generously to afford heat-radiating capacity, and large enough to carry 50,000 horse power to Niagara Falls, N. Y., and 50,000 horse power to a transformer station south of the Park. This station is for the present equipped for 25,000 horse power, with oil water-cooled transformers, and has separate high-tension and low-tension rooms, the

UNDERGROUND CONDUITS THROUGH THE PARK, CANADIAN NIAGARA POWER CO., MAY, 1904.

long-distance connections being for 40,000 or 60,000 volts. It is a fireproof building with concrete floors and tile roof.

Adjacent to the transformer is a standpipe 116-feet high and 30-feet diameter, holding one day's reserve supply in case the pumping system at the wheelpit or the rising main to transformers should get out of order, and, as it is located on high ground, it dominates the landscape. Speaking generally, the company can, with a relatively small additional expenditure, complete its machinery and transformer equipment to 100,000 horse power with an eleventh wheel in reserve, and as the plant has been designed and built substantially and along well tried lines, it forms a powerful auxiliary to the two 50,000-horse-power plants of the Niagara Falls Power Company already in operation. The three stations working in parallel on opposite sides of the river, and of a total of 200,000 horse power, can with confidence defy chance and the elements and offer to consumers almost absolutely certain and continuous power.

(E) The Ontario Power Company's Plant.—In 1887, before the wheelpit and tunnel-tailrace method of development had become so fully established as it now is at Niagara Falls, a charter was obtained from the Dominion Government for a power plant using a headrace canal which was to obtain its water from the Niagara River via the Chippewa River by reversing the natural direction of flow of the latter stream. This scheme included a group of tunnels for chuting the water from this canal to another canal at a somewhat lower level situated in Queen Victoria Park, from whence it was to be carried over the cliff at Table Rock to a generating station situated on the lower river level. This canal scheme was abandoned, however, in

CONCRETE GATHERING DAM AND OUTER FOREBAY, ONTARIO POWER COMPANY.

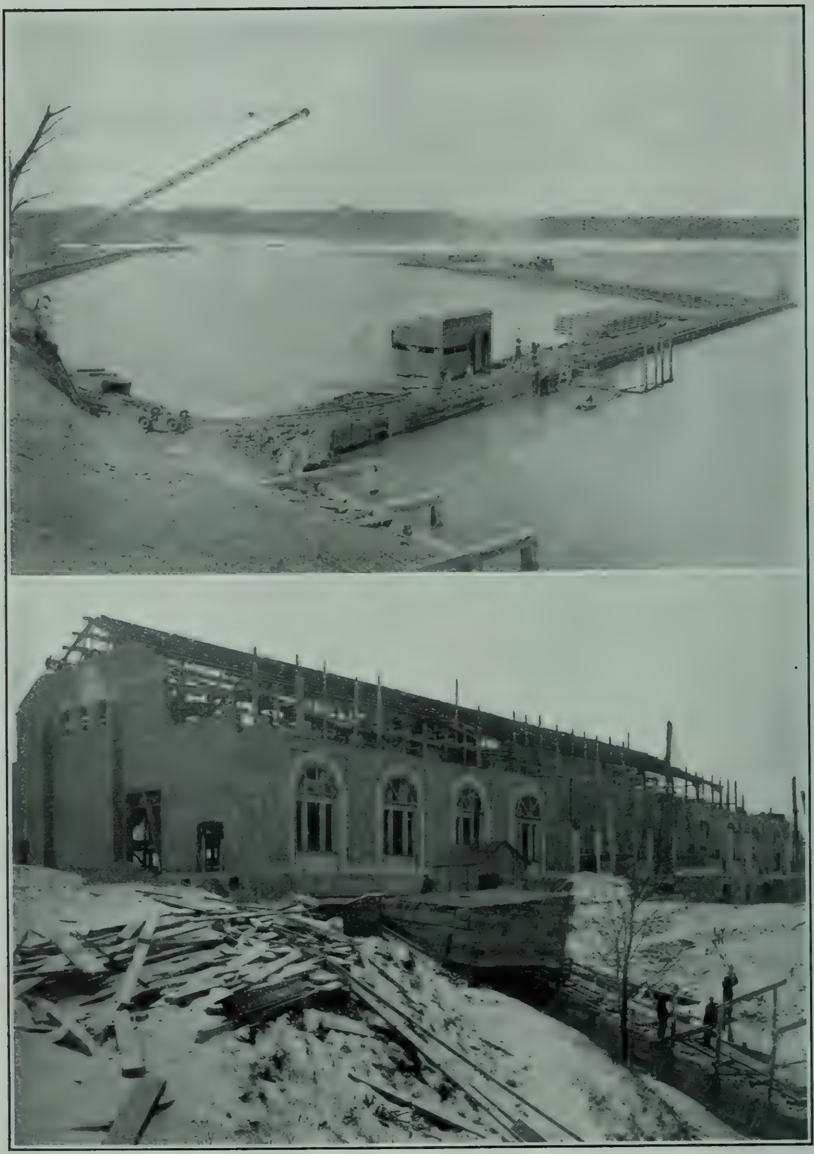
1902, and the present one adopted, which is to create a large receiving basin in the Niagara River Rapids immediately in front of the beautiful Dufferin Islands, at a point 1¼ miles from the site of the power house, and to convey the required water through a flume along the park surface to Table Rock, from which penstocks branch off downward through tunnels to the turbines situated in the generating station founded on the talus at the foot of the main cliff and about 200 yards north of the Horseshoe Falls.

Naturally, the public, jealous of the beauty of the park being marred, observed this arrangement with consternation; but its interests have been well safeguarded and the ultimate restoration of the Dufferin Islands is assured, when water is brought to its future level in the receiving basin adjacent. So also through the Park itself the flume, which is an 18-foot steel pipe encased in concrete, is to be covered over and the park surface terraced so as to disguise its presence.

The present construction, which is being vigorously pushed, and which is well on toward completion, comprehends a receiving basin for 180,000 horse power, with ample water to spare for restoring the Dufferin Island channel and for washing over the spillway dam and weirs at normal river level. As this basin is located at the head of the upper Niagara Rapids it is not likely that frazil or anchor ice will have to be dealt with. This basin, after being unwatered by cofferdams, was partly excavated in solid rock and partly formed by the concrete spillway dam, and is divided into outer and inner portions. The outer one is protected at the river face by a curtain wall of submerged concrete arches placed obliquely to the current which will tend to pass along floating ice and debris. There are three outlets from this basin, openings for admitting water around the Dufferin Islands, the main screenhouse, and the overflow dam already referred to. The screenhouse has vertical openings and steel grillages, set on inclined guides in concrete, and these grillages are removable by means of a crane, while from a visitor's point of view, the promenade on the roof of the screenhouse has a very fine outlook on the adjacent rapids. The water, after passing through the inner basin, approaches the gate house which consists of three 18-feet openings controlled by Stoney gates and surmounted by a substantial building which it is proposed to equip with boilers and steam pipes.

EIGHTEEN-FOOT PIPE, BEFORE BACK FILLING. ONTARIO POWER COMPANY.

At present one 18-foot flume is built through the park to the power house and it is proposed to carry water through it at over 15 feet per second to operate six pairs of horizontal Francis turbines and to develop 60,000 electrical horse power, which proposal will raise in the minds of hydraulic engineers the question of the regulation of this enormous mass of swift moving water. The methods which the



CONSTRUCTION WORK ON THE PLANT OF THE ONTARIO POWER COMPANY.

The upper view shows the diverting dams to unwater the intake site; the lower one shows the distributing and transformer station as it appeared in the middle of December last.

company's engineers employ to this end and the results attained will be of great interest. From the bottom of the flume six steel penstocks are carried by shafts and tunnels to the generating station, one to feed each pair of turbines. Each penstock has a gate valve and expansion joint and bifurcates to the two machines. The generating units are direct-connected and each consists of two horizontal Francis turbines, operating at 187½ revolutions, made by J. M. Voith of Heidenheim, and a 10,000-electrical-horse-power, three-phase, 25-cycle, 12,000-volt, internal revolving-field generator, made by the Westinghouse Electric & Manufacturing Company, and each unit occupies a floor space of 26 by 50 feet. Concrete draft tubes in pairs will take the tailrace water from the machines to a weir over which the water will discharge into the river. The only equipment of importance, in addition to the main units, located in the power house, consists of 1,000 horse power of exciter units (to be used not only for excitation but for lamps, motors, switches, etc.) and the turbine governors, and these are elevated at the rear of the station close to the cliff so as not to obstruct the floor space of the large units.

The power house is a substantial concrete structure, with a heavy flat steel-trussed roof, modestly crouching close to the overhanging cliff, and visions of roof gardens made verdant by the constant spray will dull the edge of any criticism anent the proximity of this pigmy work of man to the stupendous spectacle which is an emblem of the power of the Almighty.

Contrary to usual custom, the control of this station has been placed in a building on the upper plateau and over 500 feet distant; here will be located not only the controlling switchboard gallery, connected to the generating station by control circuits laid in underground conduits, but also to this same point will be brought the generated current through insulated underground cables. The building has three transformer compartments, as in the Canadian Niagara Power Company's transformer station—one for low-tension switches, a second for the water-cooled transformers themselves, and a third for the high-tension switches—and as it has a very prominent location overlooking the whole Niagara panorama, some attention has been given to the harmonious appearance of that side facing the falls.

While the head works are of 180,000-horse-power capacity, the remaining construction is being carried on with a view to the generation of 60,000 horse power, which suggests that, should an enlarged market be discovered or created in the near future, the public visiting the park will be subjected to turmoil and disorder for many years to come, long after the other two companies have put their respective areas into that condition which will satisfy the park authorities and adorn the landscape. Under present conditions, however, the park should be largely restored during 1905, and current from these works, as now under construction, placed on the market.

(F) Toronto and Niagara Power Company's Plant.—Not content to purchase power from other parties, certain Toronto capitalists obtained rights from the Government and park authorities in 1903 and, under the name of the Electrical Development Company of Ontario, at once commenced the construction of a third large power plant at Niagara Falls; and, appreciating the merits of the wheelpit method of development, formulated plans which, while maintaining the general idea of the Canadian Niagara Power Company's works, contain strong features of divergence which are briefly:

(1) Shortening the length of pit to 75 feet per 20,000-horsepower output, as compared with 96 feet for the Canadian Niagara Power Company, this being done by reversing the penstock positions of each alternate machine, thus using a common hatchway for each two units.

(2) Placing the turbine cases and lower penstock elbows on the bottom of the wheelpit instead of suspending them across the wheelpit above the tailrace. This method involves the extension of the tailrace tunnel by means of two branch tunnels, one on each side of the wheelpit and somewhat below it, and carrying a draft tube from each machine into one of these tunnels, in connection with which it is proposed to place a controlling gate at the outlet of each branch tunnel, enabling one-half of the plant to be shut down for examination or repairs in the tunnel without interfering with the operation of the remaining machines.

(3) Concrete arches across the pit at various elevations for each unit which will take the place of the steel guide and thrust girders used for carrying vertical revolving shafts of previous wheelpit installations. These concrete arches will also act as struts to prevent that creeping of walls which has been so interesting a feature of previous wheelpits.

(4) Excavation of tailrace tunnel under the bed of the river to a point behind the sheet of water of the Horseshoe Falls. This has necessitated the omission of any permanent portal work, owing to the recession of the falls, and the tunnel, although to be lined with continuous concrete faced with brick over the greater portion of its length, is to have a concrete lining made of short annular rings for

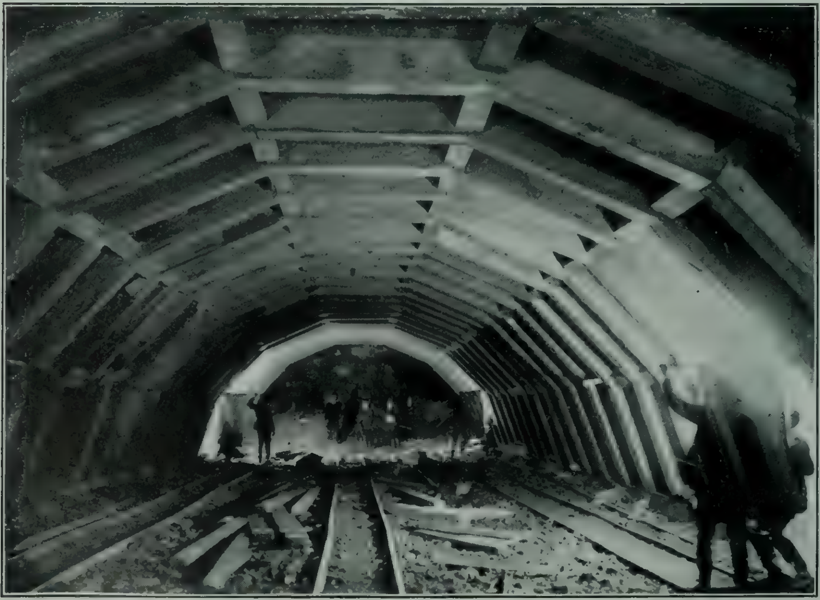
WHEELPIT EXCAVATION, TORONTO & NIAGARA POWER COMPANY, AUGUST, 1904.

300 feet from its mouth, providing for a gradual falling away of the tunnel lining, year by year, for a century at least.

This tunnel, some 1,900 feet long or 3,160 feet long including branches, is about one-half completed, the excavation being carried on by a construction shaft and horizontal tunnel extending from the west shore of the river to a point near the mouth of the main tunnel; and, after breaking through to the face of the gorge behind the falls, which was accomplished under perilous circumstances, the excavated rock has been thrown out and swept away by the falling sheet of water. This tunnel is to have a very large section, 26 feet high, 23½ feet wide, and the grade of 5½ feet per 1,000 is estimated to be capable of passing 12,000 cubic feet per second when running full.

Unlike that of the Canadian Niagara Power Company, the forebay or receiving basin for this plant is being created in the Niagara River midway between the entrance works of the two companies whose works have just been described; and, as the site selected was at the most boisterous part of the rapids, it became necessary to throw out a cofferdam enclosing this basin, extensive in length and cost and perilous in its execution beyond that of those cofferdams already built for the other companies. It is interesting to note that French Canadians have shown themselves to be peculiarly adapted for this class of work, where familiarity with handling of timbers, etc., in the raging rapids has to be combined with cool daring and endurance under continual exposure to the elements.

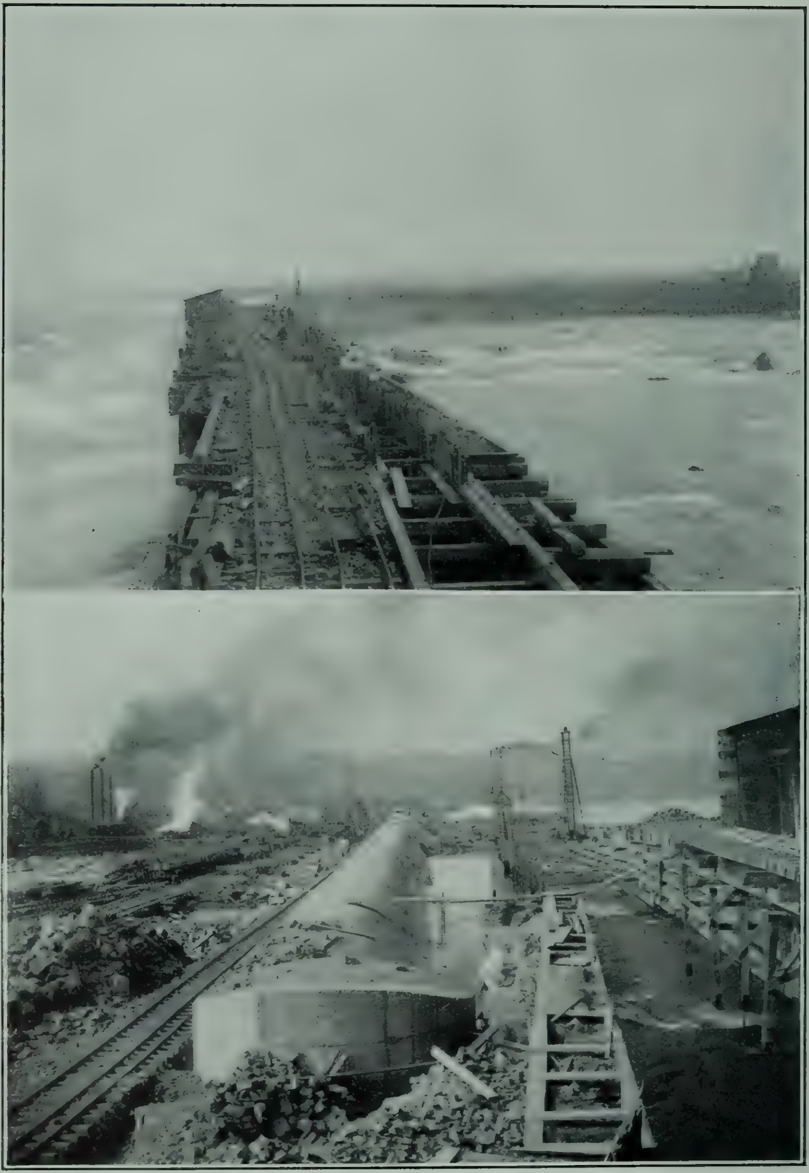
This cofferdam is composed of two lines of cribs with a puddle space between, but on completion the leakage under it was found to be so great that a third line of cribbing and second puddle space, a



TIMBER ROOF OF TUNNEL, TORONTO & NIAGARA POWER CO.; VIEW TAKEN SEPTEMBER, 1904.

COFFER-DAM BUILDING AT A CASCADE, TORONTO & NIAGARA POWER CO.

gathering flume for the leakage from the upper portion, and secondary or cross lines of cribbing with wide puddle slopes, have been resorted to, and the basin has been unwatered in detail and a very heavy spillway dam constructed which, while mainly of concrete, is capped with granite, and will take care of any overflow of water and ice which the fluctuations of the water level may subject it to. The downstream end of this gastering or spillway dam is to be three feet lower than the main portion, thus affording an outlet for heavy ice even under lowest water conditions; and some distance outside the power house is a line of submerged concrete arches coped with limestone above water, which will be the first line of defense against floating ice or debris, and the large receiving basin created will give slow velocity and tend to favorable treatment of frazil ice which may form in the rapids above. The power house proper is to be a very ornate structure of Italian Renaissance style, and will face landward. It is to contain, ultimately, eleven 8,000-kilowatt, three-phase, 25-cycle, 12,000-volt generators revolving at 250 revolutions which will be direct-connected to twin turbines situated in the wheelpit immediately beneath. The rear wall of the power house will consist of another series of submerged arches through which the water will pass to an



PART OF THE HEADWORKS, TORONTO AND NIAGARA POWER CO.

The upper view, taken in November, 1903, shows the cofferdam in place, but not yet puddled; The lower one, taken one year later, shows the upstream end of the spillway dam.

inner bay within the power house itself. This bay will have a spillway at the north end emptying into the river below, and the water before entering the penstocks will pass through an ice rack to screen floating debris out of it.

In the wheelpit will be situated eleven turbines for driving the generators just mentioned, and the hollow shafts connecting each turbine to its generator will be supported by concrete arches at two points besides at the thrust bearing. The single draft tubes from each turbine will empty upward by a sinuous course into the *bottom* of the tunnel alongside, and will therefore always be sealed. This pit is now completely excavated and good progress has been made on the draft-tube and branch-tunnel excavation. The pit excavation was carried on by drilling holes about six inches apart along the sides, which gave a fairly good surface when the benches were blasted, and was cheaper and quicker than the channelling done on previous wheelpits; but it is probable that some trouble will be experienced in fastening the brick lining to this shattered and uneven surface, especially as the leakage from the river through the seams of the rock is very heavy. This plant will have also the necessary auxiliary equipment of exciters and oil pumps, located in chambers branching off from the wheelpit, but has not yet reached the machinery stage of construction.

The company have also commenced the construction of a transformer station situated on the bluff above the park, and proposes to transmit current to Toronto, 80 miles, by three-phase, 60,000-volt transmission, the wires to be carried on steel towers 400 feet apart; it should be prepared to deliver in the summer of 1905 if current is obtained temporarily from other companies, but otherwise it is not likely that commercial service can be given to Toronto before late in 1906.

In considering the Canadian Niagara Power situation broadly, certain striking features are at once presented. We find financial faith in a demand for power at last established, although this has been rather slow in coming, but now that $20,000,000 to $30,000,000 is being invested the markets must be found.

Hamilton and district can take care of the output of the De Cew Falls plant, and the Hamilton Company are not likely to meet much opposition as they are well entrenched. Toronto, in the same way, will be subject to the Toronto & Niagara Power Company's sway, as its allied companies control the street-railway and electric-light franchises and exert a powerful influence in the city. The Canadian

Niagara Power Company is an allied company of the Niagara Falls Power Company and will be apt to export a large amount of power to the United States whenever additional markets are found there.

The fields yet unexploited are many. Steam railways will probably turn to electric when they feel *absolutely sure* of continuous power, and the group of Niagara plants should now make this possible. The various power companies also hold large blocks of land at Niagara Falls, Ontario, and will doubtless induce smelting and manufacturing industries to locate in the vicinity, and, beyond all, the many manufacturing towns in the centre of western Ontario are still unsupplied.

How much all these various demands will amount to it is difficult to estimate, but as there will be 150,000 to 175,000 horse power on the market from these plants in a few years, and as they are being developed with a view to a total output of 375,000 to 400,000 horse power, it is a safe conclusion that the probable demand within the next five years will about equal the smaller amount mentioned. On the other hand it is hard to conceive of a total demand in both countries within a present reasonable distance of Niagara Falls of more than 500,000 horse power within the next generation.

Those who are in a good position to know, however, are perhaps the most uncertain as to the future possibilities in electrical transmission and developments in the use of this and other forms of heat and power, and while we may, with apparent wisdom, build expensive works designed to endure for centuries, and say "Look how massive and grand," who can tell but that some new form of energy, or some new way of directing and using it, may, as so often has happened in the past, make these investments seem mistaken and shortsighted? For:

> "They have given to mortal man the immortal scope,
> The perilous chance, unrest, remembrance and hope,
> That imperfection may come to perfection still
> By some fabled shore."

THE ECONOMY OF SMALL-SIZE COAL FOR THE POWER PLANT.

By Percival Robert Moses.

The utilization of the small sizes of coal, formerly rejected—and, indeed, the recovery and marketing of these sizes from the old culm banks where they had long since been thrown—has passed into quiet acceptance as a phase of the modern tendency to find use and value in what was once mere waste. It is interesting chiefly in that it influences very directly the all-important question of the conservation of the world's fuel supplies. Mr. Moses presents a practical study of the matter as it affects the cost of operating the power plant, and the equipment and management of the fire-room.—THE EDITORS.

THE following brief discussion of the use of small anthracites —Nos. 2 and 3 buckwheat and other low-grade fuels— is undertaken with the idea of spreading more widely the knowledge of the value of low-grade fuels, and their great importance in the problem of reducing the manufacturing cost of power.

In the average power plant, the cost of fuel is at least two-fifths the cost of manufacturing power, and in some instances it equals three-fifths of this cost. The remainder is two-thirds labor, and the balance, oils, sundry supplies, repairs, water, etc. The two main items are fuel and labor, and this paper will be confined to one branch of fuel economy—i. e., the economy obtained by reducing the original cost of the fuel, and not that obtained through increased efficiency of engines, pumps, or other steam users.

The foundation of economical plant operation is low steam cost, and the less efficient—that is, the more wasteful—the rest of the plant is in the use of steam, the more important is the cheapening of the cost of making this steam. This fact, although axiomatic, is very generally overlooked, and while large amounts of money and "gray matter" are devoted to the gaining of a small percentage in the steam economy of engines or pumps, the burning of coal under the boiler and the complete utilization of the heat derived from this coal are matters left to the discretion of the boiler maker or the operating engineer; and even the largest plants, such as that of the New York Edison Co., have been handicapped from the start by imperfect design of grate surface.

For the same reason that efficient and cheap production of steam is more important than its efficient use, the question how to obtain the greatest amount of heat from a dollar's worth of coal is more important than the question how best to use the heat obtained from this amount of coal, although both are important. To make these points more clear, it will be well to consider briefly a modern isolated plant having from 300 to 500 horse power of engines, 30 to 40 horse power of pumps, and 300 to 500 boiler horse power. In such a plant, the coal fired under the boilers would transfer about 70 per cent. of its heat to the water in turning it into steam, and the remaining 30 per cent. would be lost, mainly up the chimney but partly through the walls of the setting and through the doors and exposed surfaces of the boiler. It is apparent than any increase in the efficiency of utilizing the heat from the coal, such as would be obtained by baffling devices in the path of the gases, by economizers, or by increased tube surface, would tend to reduce only this 30 per cent. loss, and the maximum benefit that could be hoped for would not exceed 15 per cent., as the temperature of the gases going into the chimney must be at least 100° F. higher than the temperature of the steam, even with artificial draft; and air from 50 to 100 per cent. in excess of that required theoretically for complete combustion must be supplied and must be heated to the temperature of the chimney gases. Even this apparent possible saving of 15 per cent. would usually be offset by the cost of the appliances necessary to accomplish the result. On the other hand, if by any means the number of units of heat obtainable from a dollar's worth of coal could be increased, the cost of the 70 per cent. valuable heat would be decreased in direct proportion, and the cost of the 30 per cent. waste heat would be decreased as well; that is, the saving would apply to the whole quantity used.

Before taking up the question as to how the quantity of heat units obtained from a dollar's worth of coal may be increased over the usual practice, it will be well to carry out further this consideration of losses in the plant to emphasize the greater importance of saving at the beginning of the operation of power manufacture than at the end of the process.

Assuming that 70 per cent. of the value of the fuel has been used in changing the water in the boilers into steam at 80 to 125-pounds pressure, the next point to consider is what percentage of this steam energy may be used in the engines and pumps and other power-producing apparatus. A simple high-speed engine requires 35 to 45 pounds steam per horse-power hour under usual load conditions, a compound high-speed engine from 22 to 26 pounds; simple pumps from 150 to 250 pounds, and compound pumps, 75 to 100 pounds per horse-power hour. As an engine or pump or other mechanical horse power is equal to 2,545 heat units per hour, and the production of a pound of steam under usual working conditions of feed water and pressure requires approximately 1,000 heat units, the foregoing figures of steam per horse-power hour show that with the compound engine about 10 per cent. of the steam energy is used, with the simple engine about 6½ per cent., and with the simple pump about 1½ per cent.; or, reducing these percentages to the basis of the original heat in the coal, allowing for the 30 per cent. loss, the compound engine actually utilizes about 7 per cent., the simple engine 4½ per cent., and the simple pump 1 per cent.; or putting it another way, from 93 per cent. to 99 per cent. of the energy in the coal is wasted. This is the case where the steam can be used for power only; where it can be used in the heating system or for other low-temperature work after doing its power work, more or less of the 63 per cent. to 69 per cent. remaining of the 70 per cent. available energy can be saved, as has been pointed out many times.*

Considering these figures, it will be seen that doubling the efficiency of a simple pump would decrease the loss only from 99 per cent. to 98 per cent., while doubling the efficiency of the dollar's worth of coal, would make the loss only 50 per cent. of what it was before. Furthermore, the increased efficiency of engines or pumps would be a real saving only during periods in which the steam required by low-temperature uses for heating, etc., was less than the exhaust supplied by the engines, while the saving from increased efficiency of the dollar's worth of coal would be a direct benefit at all times.

I do not wish to be misunderstood as advising lack of care or study in increasing the efficiencies of the various pieces of apparatus using energy. The figures showing the wastage are sufficient evidence of the need of care in this line, and these same figures indicate the direction in which this economy can be obtained—viz., consolidation of the various functions as far as possible, and reduction of the number of inefficient steam-using pieces of apparatus; or, as a practical example, substituting electric-driven pumps for simple steam pumps, electric elevators for steam elevators, electric-driven small compressors for small steam compressors, and supplying all these from a high-efficiency engine and electric dynamos, which should also supply the electricity for lighting, cooking, etc. The length to which this consolidation can be carried is limited by the size and character of the apparatus and the comparative cost of the electric and steam drive, but for small pumps and compressors the electric drive will be found to cost barely one-half as much as the direct steam.

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* Economy in Design and Operation of Electric Plants, THE ENGINEERING MAGAZINE, January, 1903. Efficient Use of Steam and Labor in Isolated Plants, ibid. October, 1898.

But to return to the main line of the paper, the point emphasized is the high relative importance of the cost of the heat in the coal, and the value of any cheapening of this cost.

It is impossible, in anything less than a book, to touch on all the grades and kinds of fuels, and such a discussion would be of little value, as the costs of fuels will vary in different localities, and the fuel that is cheapest in a sawmill might be dearest in the vicinity of a coal mine.

In New York City and other cities of the eastern American seaboard, unless the conditions are special, the use of anthracite (hard) coal for isolated plants is general. This coal is screened to different sizes, known to the trade as Furnace, Egg, Chestnut, Pea, No. 1 Buckwheat, Rice or No. 2 Buckwheat, Barley or No. 3 Buckwheat. Owing to the presence of slate and other impurities the average heat value of small coals is not usually as high as that of the larger coals, and this difference is more marked in the very small sizes, but it is quite possible to obtain a No. 3 Buckwheat coal with more heat units per pound than No. 1 Buckwheat.

Large-size Egg or Chestnut may have 14,500 units of heat—that is, a capacity (with perfect combustion) of raising 14,500 pounds of water one degree. Bituminous coal yields from 13,000 to 14,000 units of heat per pound of coal, and the smaller sizes of hard coal known as Pea and No. 1 Buckwheat, from 11,000 to 12,000 units of heat and—here is the main point—the still smaller sizes of hard coal known as No. 2 Buckwheat or Rice, and No. 3 Buckwheat or Barley, will average over 10,000 units of heat per pound. With a furnace and boiler capable of utilizing 70 per cent. of the heat units in the coal and test conditions, egg coal would evaporate from 9½ to 10 pounds of water per pound of coal, into steam at 100-pounds pressure; bituminous coal, about 9 pounds; No. 1 Buckwheat, 7½ pounds; and No. 3 Buckwheat, 7 pounds. In other words, the average No. 3 Buckwheat or Barley coal is only 10 per cent. less valuable, as far as its capacity for making steam is concerned, than the No. 1 Buckwheat or Pea Coals, and is only about 20 per cent.

less valuable than the soft coals or the larger anthracites. This is not a new story; it has been told by the large anthracite-mine operators for the past four or five years; but while the theory was correct and the facts were as stated, a great many difficulties developed in the burning of the small-size anthracite, and these, together with the low price of No. 1 Buckwheat, prevented their general introduction up to the period of the great coal strike. This strike finally resulted in a rise of 70 cents a ton in No. 1 Buckwheat, and of 80 cents a ton in Pea coal, and the immediate result was the investigation of methods of burning the smaller sizes known as Rice and Barley. The price of Rice delivered in New York City is approximately the price of No. 1 Buckwheat before the strike—i. e., $2.55 per ton. The price of No. 3 Buckwheat is about 30 cents less, so that if No. 3 can be used in place of No. 1 Buckwheat, the saving at present prices would be nearly $1 for each ton of coal burned. The saving in actual practice is about 60 cents a ton, the difference being due to the power required to produce forced draft and the slightly lower average heat value of the No. 3 than the No. 1 Buckwheat.

The prices of Pea, Buckwheat, and the smaller sizes of steam coals have been about as follows during the past two years. These prices are in lots of 25 tons delivered in buildings in New York City:

Pea Coal............	From $3.65	to $3.85	per ton of 2,000 pounds.
No. 1 Buckwheat....	" $3.10	" $3.35	" " " " "
No. 2 "	" $2.50	" $2.65	" " " " "
No. 3 "	" $2.25	" $2.35	" " " " "

In order to compare these coals on an equal basis, and to find their true value to the user, it is simpler to state the number of heat units in a dollar's worth of coal, and these would be as follows:

Pea Coal..........................	6,400,000	heat units per dollar.
No. 1 Buckwheat..................	7,200,000	" " " "
No. 2 "	8,400,000	" " " "
No. 3 "	9,120,000	" " " "

This comparison is still not quite correct, as deduction should be made for the steam required to supply forced draft needed in order to burn the No. 2 and No. 3 Buckwheat coals, except with exceptionally high smoke stacks and large grate surface. The steam required for this purpose varies from 2 per cent. to 3 per cent. with fan blowers, to 8 per cent. with steam blowers, and the final comparison would therefore be, with No. 3 Buckwheat as standard of value.

	Large Plants using Fan Blowers for Small Coal.	Value.	Small Plants using Steam Blowers for Small Coal.	Value.
Pea Coal...........	6,400,000	72.7	6,400,000	76.
No. 1 Buckwheat....	7,200,000	81.8	7,200,000	85.7
No. 2 "	8,150,000	92.6	7,800,000	93.
No. 3 "	8,800,000	100.	8,400,000	100.

Of course, where No. 2 or No. 3 can be burned without forced draft, the former comparison will hold; and, as a matter of fact, the steam used for forced draft is by no means a complete loss, as it results in more perfect combustion and less surplus of air, so that in practice the loss of steam is largely made up by increased efficiency. To place the matter in concrete form, if the expenditure in a plant is at the rate of $30 per day at present for No. 1 Buckwheat, it could be reduced to between $24 and $25 by the use of No. 3 Buckwheat under forced draft.

There are two methods of burning this small coal, both of which require a forced draft. It has been found by experience that, in order to burn the small-size anthracites, it is necessary to have a draft of one-ounce pressure per square inch in order to secure a proper mixture of the air and coal. The best method, for small plants of 500 horse power or less, requires a steam blower to produce the necessary pressure in the ashpit. There is a great variety of these steam blowers on the market. The main requisite is to have an adjustable rate of steam emission from the nozzles so that when the steam pressure falls the opening can be made larger, and the same quantity of air discharged into the ashpit.

The steam blower produces a pressure in the ashpit by the expansion of steam emitted from small orifices with a difference of 40 pounds or more between inlet and outlet of orifice. The rush of steam with this difference in pressure produces a powerful suction through the space surrounding the openings, causing air to be drawn into the ashpit and discharged under pressure through the grate openings.

The second method employed for plants of over 500 horse power requires a centrifugal fan similar to that made by the Sturtevant Co., or Buffalo Forge Co., with galvanized-iron air ducts carrying the air to the ashpit. The fan system is more economical in its use of steam but takes up a great deal of space, and the ducts are bulky and difficult to install in a plant already in operation.

Of importance next to, if not greater than, that of the apparatus for producing the draft and delivering the air, is the system of grates

The number of grates devised for burning the small-size coal is very large. Here again two distinct principles are met; the first, largely used with steam blowers, consists of a heavy, almost solid grate with small openings spaced 3 or 4 inches apart. With grates of this character, the ashes do not fall into the ashpit at all, but are drawn out through the fire doors, the good fire being pushed back onto a so-called cleaning platform.

The other system of grates is built on a principle exactly contrary to this, and as much air space as possible is left. Grates have even been devised made of wire mesh. This type of grates is used almost exclusively where the pressure is obtained from the use of a centrifugal fan or blower, or when the natural draft is sufficient.

In both systems of forced draft, the draft-producing apparatus is controlled automatically by a valve opening or closing the steam supply as the steam pressure of the boiler falls or rises. In some cases an ordinary damper regulator is used, controlling a balance valve in the line from the boilers to the steam blowers.

Where the fan blower is used, a reducing valve is installed which opens, more or less widely, the steam connection to the engine driving the blower, allowing the blower to speed up or slow down, but not to stop completely or run away.

With either system, when the blast is at its maximum, the tendency will be to drive the gases through the boiler and up the chimney without giving up the full amount of heat. This would be particularly the case if the damper opened wide at the same time when the blast pressure was at its maximum. In order to minimize this waste, the damper is frequently controlled so that at a point of maximum blast the gases going up the chimney will be sufficiently held back to prevent undue waste of heat, and at the same time not so much as to cause the gas to be blown out into the fireroom.

Under forced draft with a fan blower, the tendency to clinker is noticeable, and this can be greatly reduced by blowing the exhaust from the steam engine in with the blast. With the steam blower no difficulty is experienced with clinker, particularly with the type of grates mentioned. Where it is feasible, it is advisable to have the blast into the ashpits pass through the back connection of the boilers, thus allowing the air on its way to the furnace to be partially heated. In a few cases a system of pipes in the smoke flue has been installed, through which the air was delivered to the blast apparatus: such devices must be of very low efficiency and of small value.

There are no bad effects to boilers or setting with a forced-draft system, provided it is properly handled and intelligently installed. The grates must be larger in order to burn small anthracites than to burn the larger sizes, and they must be designed for the work. The combustion chamber, too, should be designed for ready cleaning, as the pressure of the blast tends to carry over fine ashes and soot instead of allowing it to remain on the grates, and there are a few similar minor points to be taken care of in the setting and connection of the boilers.

Firing is somewhat harder with No. 3 Buckwheat than with No. 1 Buckwheat, as firing and cleaning must be done about twice as often; but the quantity of ashes taken out each time is less, and generally no increase in the force is necessary. Where there is only one boiler, and this is run one shift and banked the remainder of the day, some difficulty is experienced over night and in starting up next morning. Unless the draft is exceptionally poor, it is always possible to raise sufficient steam pressure to run the blowers.

The forced-draft system is of no advantage with an insufficient chimney area, as it is impossible to push a column of heated air through too small an area of stack, for instead of going up the stack it will find its way back into the fire-room.

With a correctly designed and proportioned setting, and ordinary intelligence in handling, there is no reason why the smallest sizes of anthracite fuel and other low-grade fuels should not be substituted for No. 1 Buckwheat and Pea coal and a material saving obtained.

ELECTRIC-POWER SUPPLY FROM CENTRAL STATIONS IN GREAT BRITAIN.

By G. L. Addenbrooke.

The importance of Mr. Addenbrooke's subject, from the merely material point of view, is indicated by his conservative estimate that the immediate prospective investment in electric power supply in Great Britain is £100,000,000, and that with the approaching electrification of the railways this amount may be trebled. The movement, like the development of Niagara, described by Mr. C. B. Smith elsewhere in this issue, is further marked by its certainty scarcely less than by its magnitude. We are especially glad to present, in this issue of THE ENGINEERING MAGAZINE, reviews so clear and comprehensive covering the most significant power undertakings—technically, financially, commercially, or economically considered—which the age affords.—THE EDITORS.

IT has been put to me that a short review of the present position and prospects of this industry would be interesting. The subject is, however, of so far-reaching character, and such changes and progress are being made at the present time, that this is by no means an easy task.

The first attempts to put into commercial shape the calculations and proposals of engineers in the direction of public electric-power supply over extended areas were made in the Parliamentary session of 1897-8, when the group of provisional orders applied for by the Midland Electric Corporation and the bill of the General Power Distributing Company, which latter was of a much more ambitious character, came before a joint committee of the two Houses of Parliament presided over by Lord Cross. The general views which were formed by this committee, as a result of the evidence laid before it and as given in a report which it subsequently laid before Parliament, have formed the basis on which committees appointed to deal with electric power bills have since acted.

Supported by the recommendations of this committee, the Board of Trade granted the powers asked for by the Midland Electric Corporation; but the bill of the General Power Distributing Company was rejected by the special committee before which it subsequently came, owing to the opposition of the large towns included in the area. The fight, however, was a most useful one, as it showed the lines on which a bill would have to be framed to secure fair chances of passing in the face of the antagonistic frame of mind with which it was evident the larger authorities would meet proposals of this character.

In the next year's session, the increasing opposition shown by the local authorities to extensions asked for by the Midland Electric Corporation made it clear that the method of applying for powers, by means of groups of provisional orders, which was favoured by the Board of Trade itself, had little or no chance of being successful again if tried elsewhere on a large scale; and the session was barren, except for the first bill of the Walker and Wallsend Company, on which a large and flourishing business has since been founded, though this bill covered an area of only about 4 square miles.

In the meantime, the matter was being reconsidered by a certain number of men connected with the electrical industry, and as the general advance of electric-power distribution in other countries showed more clearly its practicability, notices for two groups of bills were given in the session of 1899-1900, and in the ordinary course came before what is familiarly known as "Sir James Kitson's committee." These groups of bills comprise, on the one hand, the South Wales Electrical Power Distribution Company's act and, on the other, the Newcastle-on-Tyne Electric Supply Company's act, and the County of Durham, the Lancashire, and the North Metropolitan acts. I have divided these acts into two groups, because there is an important fundamental difference in their character. In the South Wales act, power was obtained to deal direct with consumers. In the other acts, supply could be given only in bulk and through local authorities, or other authorised undertakers, who had to obtain separate powers to carry out the distribution themselves. Of these two groups of acts, it is obvious that the South Wales type is the better act from the commercial and engineering points of view.

The passing of these acts set up a double standard—supply through authorities in cases where the opposition of the local authorities was extreme, and direct supply to customers in cases where arrangements could be made with these authorities. Subsequent legislation has proceeded on these lines, though every year since there has been a greater tendency on the part of promoters to draw their bills on the lines of the South Wales act, and Parliamentary committees, seeing the useless difficulties and complications entailed in supplying through the local authorities, have been more and more willing to grant powers on what may be briefly called "South Wales" lines.

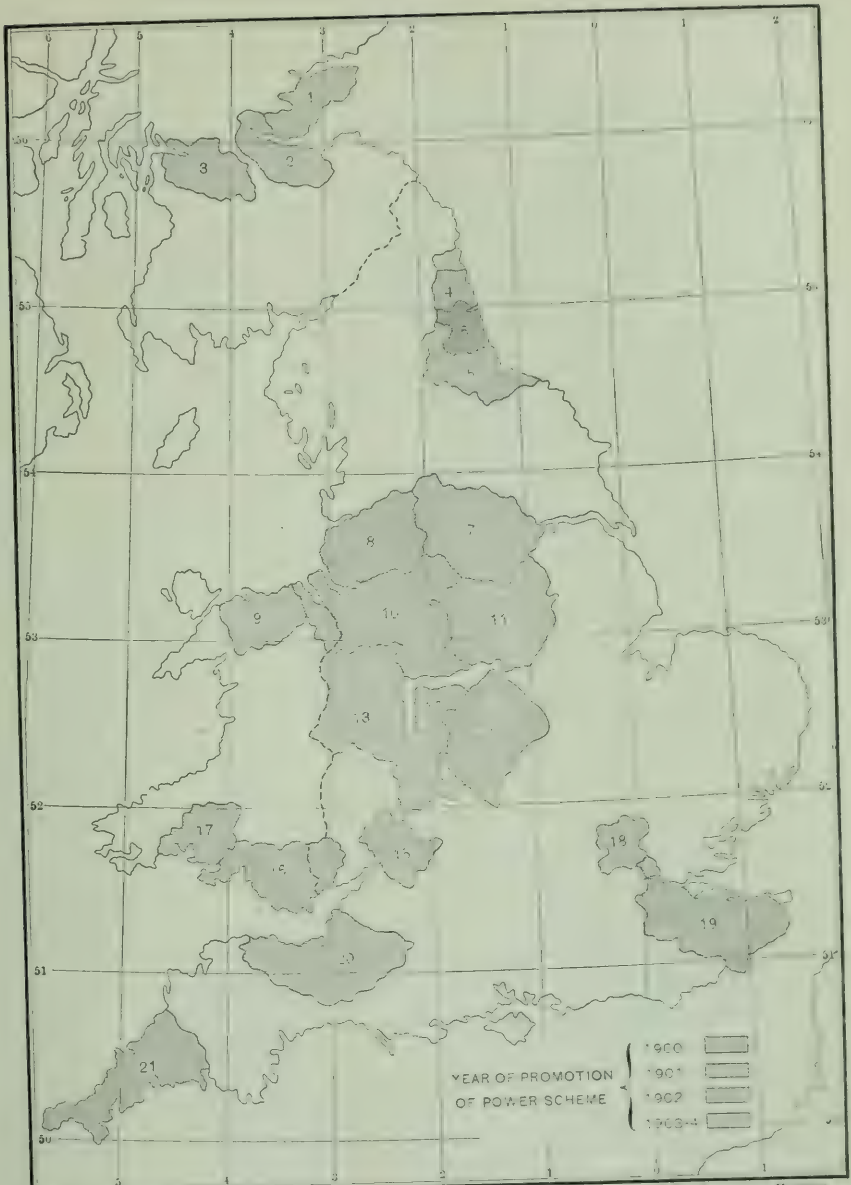
Encouraged by the success of these acts, promoters succeeded in 1901 in obtaining powers for the following electric-power acts—the Cleveland & Durham, the Clyde Valley, the Yorkshire, the Derbyshire & Nottinghamshire, and the Shannon Water Power acts. These were followed in the session of 1902 by the Leicestershire & Warwickshire, the Carmarthenshire, Cornwall, Gloucestershire, Kent, and certain supplementary power acts. In 1903, the Fife Electric Power act, the Shropshire & Worcestershire, the North Western, comprising parts of Staffordshire and Cheshire, the Scottish Central, the Somerset & District acts, and the act amalgamating the Walker & Wallsend Company with the Newcastle-on-Tyne Electric Supply Company were passed. In 1904 an act covering a large part of North Wales, and in which the generation is intended to be by water power, was the only act passed. This, therefore, represents the position of matters today from a legal aspect. The areas covered by these acts are shown approximately in the accompanying map, and may be said to cover nearly all the important industrial areas in the United Kingdom which are not comprised within the boundaries of large towns. The map will be found on page 765.

From this short review it will be seen that the history of electric-power legislation already extends over seven years, during which time the principles involved, both practical and general, have been subjected to the criticism of technical and commercial men. At their first inception, these projects were looked upon doubtfully by a large proportion of the engineering profession; but, owing to the technical advances which have taken place since the idea was first promulgated, scepticism in the profession itself on the score of practicability has become a negligible quantity. Indeed, the ground for criticism is now confined to the question whether power companies will be commercially successful in the face of the prices at which those who require mechanical power can generate it for themselves.

While, however, advances have been made during the last seven years from what may be called the "private-supply" point of view, still greater advances have taken place on the central power-supply side of the question, and particularly during the last eighteen months facts and data have come to light which, when thoroughly digested, must in the opinion of any fair-minded man who thoroughly examines the question, tell in favour of central power supply in a large proportion of the cases where mechanical power is required. It can now more and more clearly be shown, not only from engineering calculations but from appeals to accomplished facts, that a power company moderately financed, with well-designed works and good administration, in any area in which there is a sufficient demand for its product, should form a sound commercial investment for capital.

This leads us directly to the consideration of what is the present position of the power companies and what are their future prospects. It is one thing to obtain an act of Parliament granting powers for the accomplishment of some definite object, however desirable, and another thing to obtain the necessary capital and to carry these powers into effect; and this is especially the case where the undertaking breaks fresh ground and precedents cannot readily be appealed to. The acts above enumerated were most of them obtained during years of prosperity. Now experience shows that after an act of Parliament is obtained, it nearly always takes at least eighteen months or two years before plans can be fully prepared and the necessary financial arrangements made for putting the work in hand; and thus it has happened that before the majority of these power companies were ready with their projects in final form, they were face-to-face with what are called in financial parlance "lean times," when the difficulties of raising money for large undertakings are greatly enhanced. Under such circumstances, acts of Parliament are not infrequently allowed to lapse altogether; and the very fact that work under them is proceeded with is a great test of the strength and vitality of the movement which underlies them. It is, therefore, doubly interesting to enquire into what has actually been accomplished in obtaining capital and commencing works by the companies constituted under the acts enumerated above.

In the first place, it must be premised that the promoters of power companies have never been able to hold out to investors the possible prospects of obtaining that huge return on investment which is the attractive feature of mining and similar speculative classes of enterprise. The objects that the promoters of power companies have had in view have been to create sound industrial undertakings, offering a moderate but safe return on capital invested, such as is obtained in the case of railways and water or gas stocks. Although when the dividend-paying stage is once passed capital can be readily found to almost unlimited amounts, yet for these very reasons the initial stages are more difficult, particularly when the enterprises are of a technical character and do not very readily appeal to the information and intelligence of the general public. For these reasons, a very large proportion of the finance which has so far been found for the power companies has been obtained through private channels, or has come from people more or less directly connected with the movement and who have had special opportunities of forming a judgment of the prospects of the undertakings in which they are investing. It is



The Engineering Magazine

SKETCH MAP SHOWING THE AREAS IN ENGLAND, SCOTLAND, AND WALES OVER WHICH PARLIAMENTARY POWERS FOR ELECTRICITY-SUPPLY HAVE BEEN OBTAINED.

The companies holding the powers designated by corresponding numbers on the map are as follows:—1, Fife; 2, Scottish Central; 3, Clyde Valley; 4, Newcastle Electric Supply—Newcastle and District Lighting; 5, County of Durham; 6, Cleveland and Durham; 7, Yorkshire; 8, Lancashire; 9, North Wales; 10, North Western; 11, Derbyshire & Nottinghamshire; 12, Midland; 13, Shropshire & Worcestershire; 14, Leicestershire & Warwickshire; 15, Gloucester; 16, South Wales; 17, Carmarthenshire; 18, North Metropolitan; 19, Kent; 20, Somerset; 21, Cornwall. Powers have also been granted to an Irish company known as the Shannon.

obvious that capital obtained in this way is far more difficult to come by than in cases where an issue can be readily underwritten and a successful appeal made to the public at large. From the fact that most of the capital at present embarked in the power companies has been obtained in this way, it is not easy to give cut-and-dried figures in each instance, but data and information in my possession show that, so far, a sum of about £4,000,000 has already been spent or is in process of being spent on these enterprises in the United Kingdom, and this sum will probably increase by another £1,000,000 in the current year. This sum is a small one when compared with the capital which may ultimately be needed when the movement is thoroughly established—indeed, I think it probable that within the next fifteen years a capital of £100,000,000 will hardly cover the work which lies before the power companies; and should, later on, the railway companies work with the power companies in taking the supply they may require for electrification purposes, this capital may even be doubled or trebled. Nevertheless £4,000,000, the approximate sum so far subscribed, is a large amount in itself, and is also a large sum to be already embarked in undertakings of this character which were first practically brought forward only seven years ago, and which on their inception have had to contend with very great difficulties, both legal and financial.

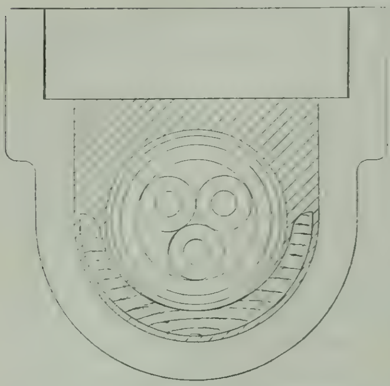
As has been stated, it usually takes between two and three years after an act has been obtained to conduct the final negociations with local authorities and other parties interested, to rearrange the personnel of the company with a view to active operations, to get out a final and satisfactory engineering scheme, and lastly to secure the necessary financial support and backing, the latter operation naturally being dependent a good deal on the state of the financial world at the time. For these reasons a number of the companies above enumerated have hardly had the requisite time since their acts were passed to complete their arrangements for making a practical commencement of their works, but several of the companies constituted under the earlier acts have already done so, and it is proposed now to give a brief account of some of these.

The amount of space which can be devoted to each company in this article, which is intended to be of the nature of a general review of the situation of the power companies, is small. It must be remembered that each is already either a large undertaking or is the nucleus of one, and, further, that each one presents special and distinctive engineering features with regard to the conditions of supply and the character of the customers to be served. All that can now be done is to give a few brief particulars of the operations of the leading companies to date.

The company which has thus far attracted the largest amount of attention from writers is the Newcastle & District Company, formerly called the Walker & Wallsend Company. At an early stage this undertaking entered into a close alliance with a company owning the lighting supply of a large part of Newcastle-on-Tyne. The company was also able to secure the supply of a system of electric tramways, and as its power station is located in the midst of a number of shipbuilding and engineering works of a character very suitable for electric driving, it was at an early stage able to secure a large clientele and has been from the first a sound dividend-paying concern. Later it secured a bulk supply for the County of Durham Power Company, operating on the south bank of the Tyne, and recently obtained a contract to supply the North Eastern Railway with the power needed for the electrification of about 37 miles of main-line railway. To meet these and other increases in the demand for power for works within its area, the company has lately completed a new station on the Tyne, at Carville. As a matter of general interest, a photograph is reproduced (p. 769) showing two of the 7,000-horse-power Parsons turbo-generator sets already installed, and attention may also be drawn to the portion of the building itself which is shewn in the background and which, it will be noticed, consists of an iron framing with corrugated galvanized-iron sides. This company has recently enlarged its district to the north and is commencing the supply of a large colliery area in Northumberland.

Another company which started contemporaneously with the above undertaking is the Midland Electric Corporation for Power Distribution, Limited, whose district covers a large portion of what is known as the "Black Country." This company, though founded primarily as a power company, has been rather treated by its present administration as a lighting company giving a certain amount of power supply, and thus its progress has been by no means so rapid as it might have been (considering the richness of its area) had a bolder policy been pursued. It is, however, accumulating a large business and is supplying light and power in at least two directions up to distances of eight or nine miles from its power house.

The company, however, which is at present attracting most attention is the South Wales Electrical Power Distribution Company, whose rights are practically co-extensive with the celebrated South

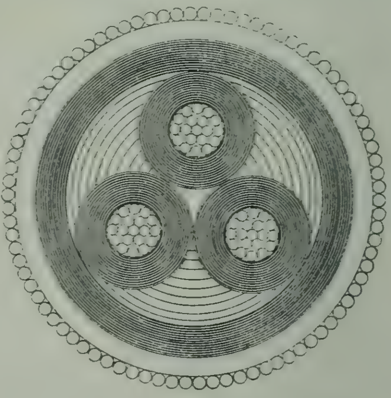


CABLE AND 4-INCH EARTHENWARE TROUGH, SOUTH WALES.

Callender's Cable & Construction Co., Ltd., London.

Wales coalfield. This company is being watched closely because it has been administered from the first purely as a power company and has been started entirely off the ground, so to speak—that is, without reliance on existing lighting or tramway supply or on contracts negociated beforehand. The moving spirit has been Mr. Graham Harris, the surviving partner of the firm of Sir F. Bramwell & Harris, engineers, of Westminster, assisted by a powerful backing of electrical manufacturers and local men of influence. The undertaking had to meet many difficulties at the start, and questions of policy have made it desirable to start three smaller stations to serve various portions of the area, as well as the main generating station which lies below Pontypridd at the foot of the Rhondda Valleys. Two illustrations of this station are given, one showing an exterior view, the second (on page 770) a portion of the generating plant.

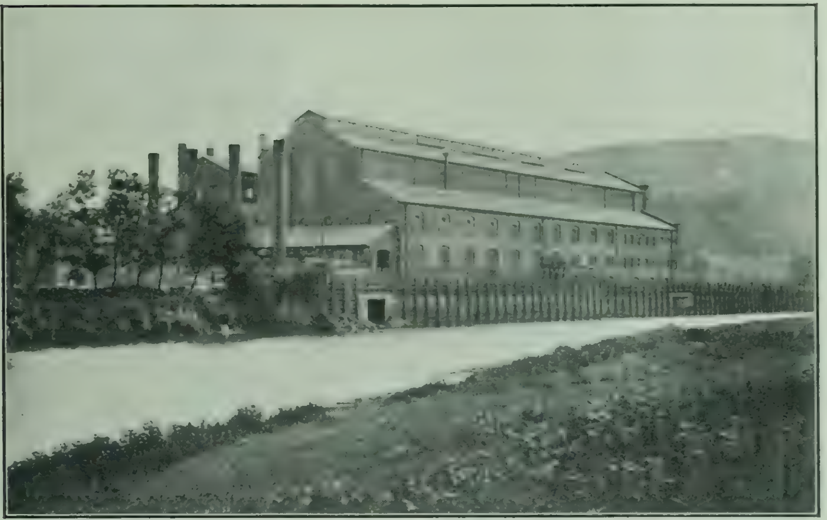
The points of interest are that the water-tube boilers are each furnished with a separate iron chimney, instead of one large stack for the whole. The generator plant shown consists of two Willans-Ganz sets, each capable of indicating about 3,000 horse power. Three further similar sets are also ordered and are to be immediately installed to meet the growing load. The station is situated on the banks of the Taff, whence the water for condensation is derived.



SECTION OF CABLE, 11,000 VOLTS, SOUTH WALES.

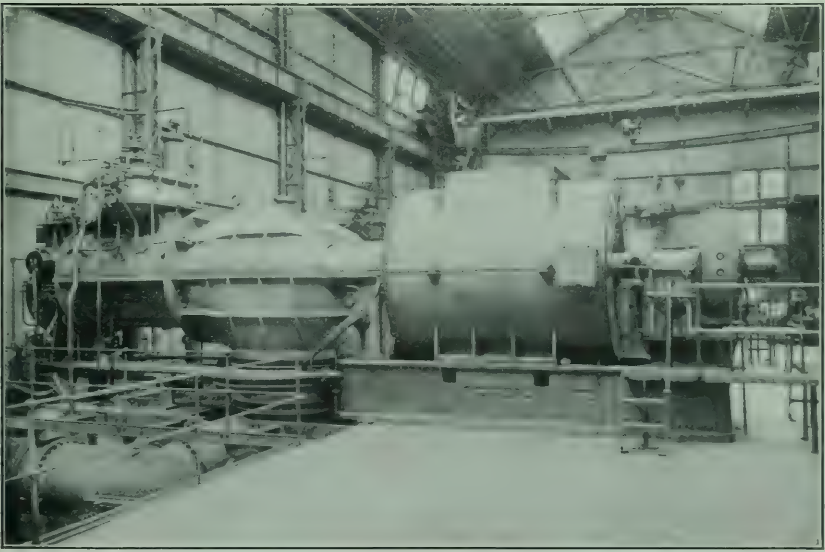
Paper-insulated and lead-covered. Callender's Cable & Construction Co., Ltd., London.

This station has now been in operation about nine months, feeding a large system of mains with three-phase currents at 25



PONTYPRIDD POWER STATION, SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.

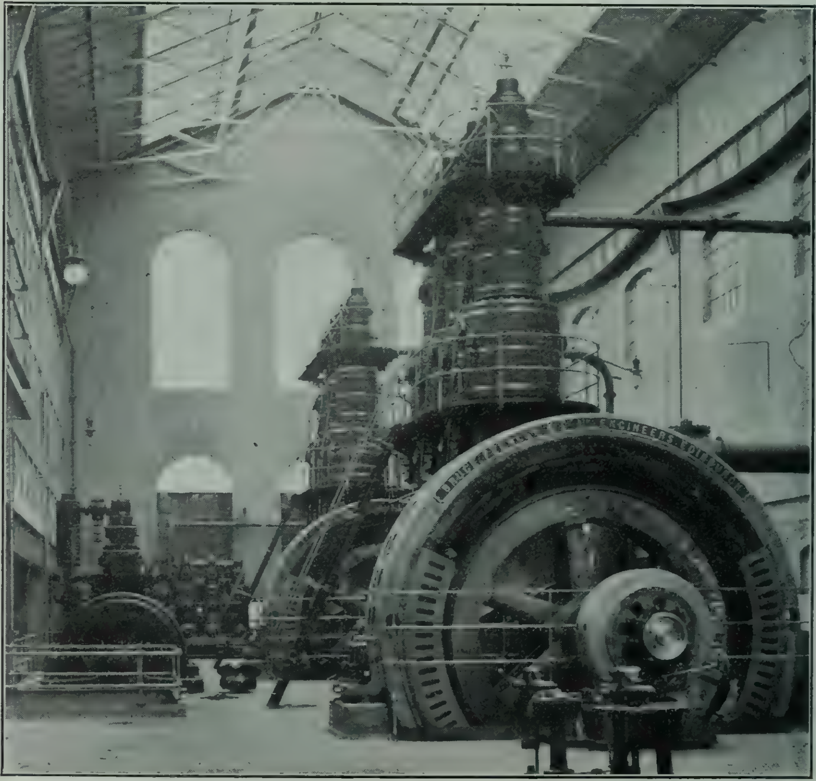
periods and a pressure of 11,000 volts between each two conductors. The current is led to sub-stations, the interior of one of which is shown on p. 771, where the pressure is let down to that needed for working motors in collieries and factories. The working of the mains has been singularly successful and free from trouble. Wattstown,



INTERIOR OF CARVILLE POWER STATION, NEWCASTLE ELECTRIC SUPPLY COMPANY.
Showing 7,000-horse-power turbo-alternator by C. A. Parsons & Co., Newcastle-on-Tyne.

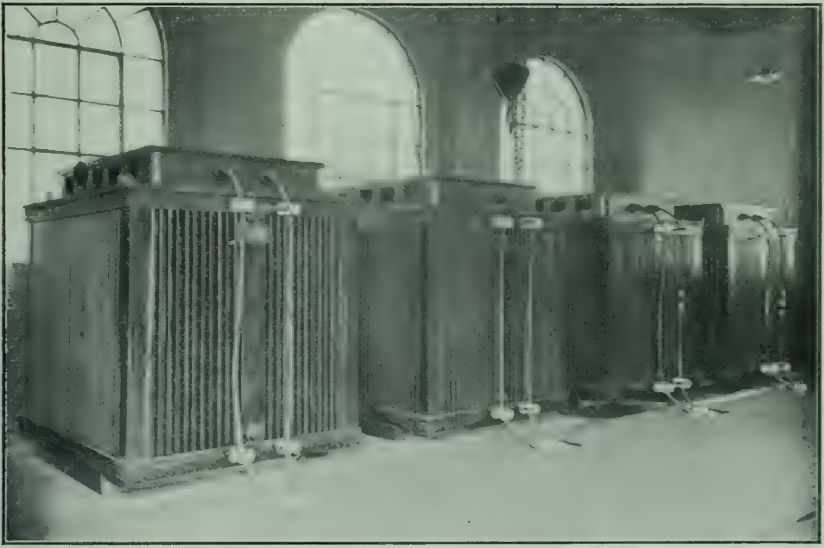
which is nine miles from the station, has been regularly supplied since last March; the Cambrian Colliery, at a distance of eleven miles, since last June; and the Glamorgan Colliery, which is ten miles from the works, since last August. A drawing showing a section of the cable with which these results have been obtained is given on p. 768.

Although there was a good deal of anxiety for some time as to whether the large collieries in the district would take current from an outside source in preference to generating it themselves, the results up to date have more than justified the confidence of the promoters. Although the station has not yet been running a year, orders for supply to the extent of over 11,000 horse power have been actually secured, negociations are proceeding regarding an additional 19,000 horse power, and enquiries have been received as to about 30,000 horse power further, a good deal of which is certain to result in business.



PONTYPRIDD POWER STATION, SHOWING PART OF THE GENERATING PLANT.

As showing the class of business obtained, the following particulars of power being supplied to various collieries may be interesting: United National, Wattstown, 710 horse power; Glamorgan Coal Company, Llwynypia, 800 horse power; Cambrian, Clydach Vale, 185 horse power; Lewis Merthyr, Hafod, 374 horse power; Albion, Pontypridd, 800 horse power; New Windsor, Aber, 417 horse power. A further contract covering the initial supply of 2,200 horse power to one colliery undertaking has also been concluded. In most of these cases, further orders for plants have been or are being placed, or are contemplated, and additional customers or applications for supply are being continually received.



A SUB-STATION OF THE SOUTH WALES ELECTRICAL POWER DISTRIBUTION CO.

The capital so far subscribed consists of £450,000 in ordinary shares and £150,000 in debentures, but to meet the continually increasing demand for power, a further issue will have to be arranged during present year.

The next companies demanding notice are a group of three, whose first power stations are all on the verge of completion and which will all probably be supplying energy before this article is in the hands of readers.

The first of these both as to the date of its act and as to the importance of its area is the Lancashire Power Company. The act when obtained, however, needed a great deal of negociation work with local authorities before it could be applied with commercial

THORNHILL POWER STATION, YORKSHIRE ELECTRIC POWER COMPANY.

success. This has in the interval since the passing of the act been in a great measure accomplished, and the company was privately capitalized to the extent of about £300,000 some eighteen months since. The initiative in the matter was largely taken by what is known as the "Edmundson group," who have been so successful in dealing with the lighting of a number of moderate sized and small towns. The directorate is a very strong one, and the area has within it steam engines now in use totalling over 1,000,000 horse power. There is, therefore, plenty of scope for business as soon as the dog-in-the-manger policy of the local authorities is surmounted, which the trend of public opinion makes more and more likely.

The Lancashire Company is just completing its first station on a site near Bolton, which is to contain initial plant capable of supplying about 6,000 horse power at 11,000 volts and 50 periods, three-phase. The prime movers are to be Curtis turbines, and the station is almost a fac-simile of that of the Yorkshire Electric Power Company which will next be noticed and a photograph of whose station at Thornhill is reproduced herewith.

The Yorkshire power act is on much the same lines as that of the Lancashire Company and since it was obtained has called for much negociation with local authorities to get a clear field. Good progress

INTERIOR OF THORNHILL POWER STATION. GENERATING PLANT IN COURSE OF ERECTION.

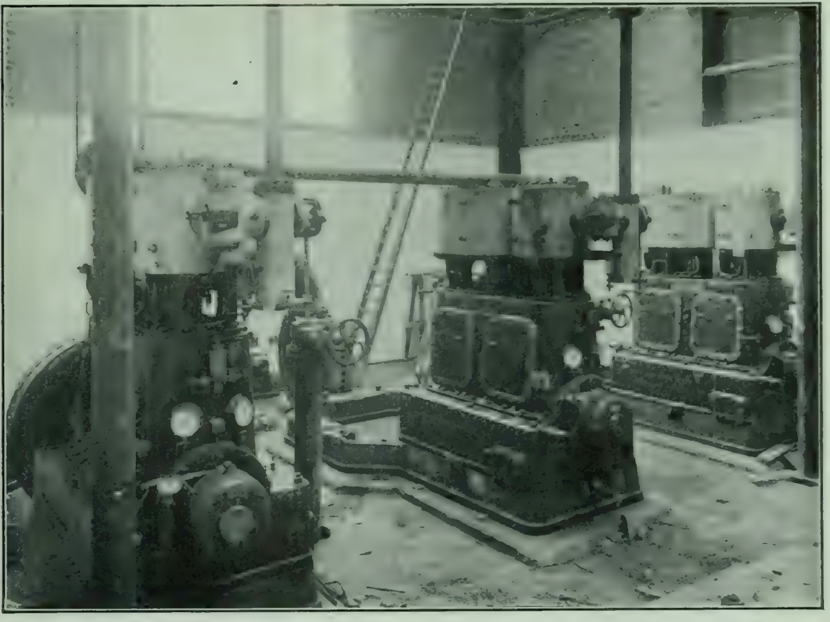
has, however, been made in this direction, and several considerable contracts have already been booked and the prospects are considered very favourable. The Yorkshire Company issued a public prospectus about eighteen months since, but it is an open secret that the greater part of the £300,000 of initial capital has been found by powerful interests who considered the undertaking worthy of the necessary support in its initial stages. The Thornhill station will contain about 6,000 horse power of plant available to commence with, and its supply will be three-phase at 11,000 volts and 50 periods.

The third of this group of companies is the Clyde Valley Electrical Power Company, which hold powers over the rich area having Glasgow for its centre, though the company is excluded from operating in Glasgow itself and in some of the other large towns in its area.

Shortly after its act was obtained, this company allied itself with a financial group in close touch with the British Westinghouse Company, and so far no attempt has been made to obtain finance from outside sources. The subscribed capital is about £600,000, which is gradually being paid up as needed. Two power houses are under construction and near completion, one at Yoker and one at Motherwell; they are each intended to have a capacity of about 13,000 horse power, with arrangements for extensions. Westinghouse-Parsons turbo-alternators are to be used for generating the current, which is to be three-phase at 11,000 volts and 25 periods. There are in the area a great number of steam engines now in operation, and the company hopes to dispose of a large amount of electrical energy in replacing these, and otherwise.

Besides the above companies, the County of Durham Company, the Cleveland & Durham Company, the Nottinghamshire & Derbyshire Company, the Fife Company, and the Scottish Central Company have all started works to deal with certain portions of their areas. These works are as yet on a smaller scale than the above, but they are designed for extension later, as soon as the possibilities of power supply are more generally appreciated and capital can be secured for operations on a more extended scale.

Another interesting company is the Metropolitan Electric Power Company, which has obtained powers to supply electric energy in bulk over an extended area to the north and east of London and which has recently completed a very up-to-date generating station at Brimsdown, near Enfield. The initial plant consists of three 1,000-kilowatt Parsons turbo-generator sets supplying three-phase cur-



INTERIOR OF THORNHILL STATION, YORKSHIRE ELECTRIC POWER COMPANY.

rent at 11,000 volts and 50 periods, chiefly, so far, for tramway supply and for supply in bulk for lighting certain areas.

In the case of several of the other companies which have not been specifically noticed, arrangements are in an advanced position for making an early commencement of operations. It will thus be seen that on the whole the movement is rapidly developing, and with the advent of better times and greater confidence amongst investors each success will undoubtedly be followed by further developments, since none of the power companies, even those which have put up the largest generating stations, can yet supply more than about 10 per cent. of the horse power within reach of the mains from the stations they have so far erected.

In this connection, it is important to observe that the work of power companies will grow by what they feed on—that is, as they become larger they will be able to supply at progressively diminishing rates of cost, and therefore the larger they grow the lower prices will they be able to charge and the larger will be the proportion of the total power utilized within the district that can be economically supplied from their mains in preference to local generation. I have endeavoured to deal with this aspect of the subject in an article in *Engineering* to which readers must be referred for further detail.

One of the most complicated subjects to be dealt with in power supply is found to be the question of making a fair and equitable arrangement with the consumer—that is, to give the consumer all the advantages that can be given and at the same time to secure that the power company is properly remunerated under all circumstances for the work it does. Agreements with power consumers may vary in value from a few pounds per annum up to several thousands. When they approach the latter figures, very slight alterations in the tariff or in the way it is applied may mean differences of very substantial sums. Moreover, it is often very difficult at present to get a customer to understand the real nature of such an agreement and what is the true operation of the different clauses. Of course, all these obstacles are incidental to the development of a great new industry and need much thought on the part of those who are interested in it, but such things straighten themselves out in time and become the taking-off point for further advances. The question of price as related to the hours of use per diem and per annum, it may be pointed out, is of relatively more importance in a station operated by steam than where there is a perpetual water power which, during a good part of the day, would run to waste if the load did not utilize it to the full. Broadly speaking, most of the companies are basing their prices on a sort of double sliding scale, in which the price is made to decrease—firstly, as the current is used for longer periods per diem or per annum beyond a certain fixed minimum, and again a further series of discounts being given as the total quantity of energy taken per quarter increases. Thus a long-hour consumer who takes a large horse power secures a double advantage. Further reductions in addition to these are in some cases offered when the customer will agree to shut off his power supply during the two or three hours when the load is heaviest on the station, employing it only at other times. This can often be managed in the case of mine pumping. Besides these factors, agreements have often also to embody special arrangements, as to bringing the mains to the customer, the length of time for which the agreement is to run, and certain other points. It will thus be seen that the making of fair arrangements with customers is by no means a simple affair, especially to start with, though as soon as people understand clearly the principles on which agreements of this kind are based negociation becomes much easier.

In connection with the supply of consumers with electric energy, the selling of motors and other appliances to them on hire-purchase terms is already becoming a considerable business and one which is likely to develop greatly, as it helps the power company to increase its load quickly and the customer can call on the power company or some allied institution to keep his electrical apparatus and plant in order and to see that it works efficiently.

Distribution by the power companies has hitherto been entirely by means of cables laid underground, but as the Board of Trade has now relaxed the ridiculous restrictions on overhead transmission, which have so long held back the electrical industry in Great Britain, it is practically certain that this latter method of transmission will gradually come largely into use in the future, at any rate for transmitting energy to long distances and for serving the less rich and more scattered districts within the areas of the power companies.

Such, then, is approximately the present position of what are called colloquially "the power companies" in Great Britain. It remains to say a few words on their future prospects. I have already indicated the belief that their future will be a considerable one in any event. The power companies which have started are up to the present exploiting only the richest parts of their areas, and the plant so far being laid down cannot on an average replace much more than a tenth part of the horse power of engines already at work in the areas which can be reached from the stations already erected or being erected. Most of the areas of the different power companies moreover, will need three or four power stations to cover their areas, if the present supply pressure of 11,000 volts is adhered to. Even supposing that supply by the power companies does not replace anything beyond the smaller engines, and only comes in where electric driving is specially suitable, all the power companies have room for large extensions. If, however, as seems probable from the way things are going, as the power companies increase the size of their undertakings they are able to reduce their prices—and further developments and improvements will enormously help towards this end,—it is hard to assign a limit to the amount of power which they may ultimately supply in their different areas, particularly considering that there is likely to be a great growth in the use of power altogether when once it can be obtained so readily, in such an available form and on such moderate terms. Further, the power companies will probably supply large quantities of energy in their respective areas for driving tramways and inter-urban railways, for lighting, and later on possibly for heating and ventilating purposes. Finally, it is quite possible that if railway electrification comes about, the railway companies in many districts may find it advantageous to come to some working arrangement with the local power companies rather than to set up isolated power stations for themselves.

To say more would be to enter into the region of romance. I will therefore end with only one further remark. During the last quarter of a century the problem of electric generation, transmission, and utilisation has been the focus round which the more practical physicists and the more scientific engineers have concentrated their efforts. There is still room for an immense amount of work in the same direction, but so much has been done already that there is evidence that the more ardent spirits are beginning to look a step further back. It seems as if the great central physical and engineering problem of the next quarter of a century would be the more economical production of energy from coal and the liquid hydrocarbons; that is, efforts will be concentrated on improving the steam engine, the gas engine, the oil engine, and probably the gas turbine, or possibly some new form of prime mover, with the object of attaching them to the already highly efficient electric generators, transmission line, and motors, lamps, or heating appliances. During the last few years great advances have already been made in improving the thermal efficiency of prime movers. With our present knowledge and appliances, with the means of accurate testing which the coupling of an engine to a dynamo gives, with great power stations managed by highly skilled and technical staffs to look after the plant required, who shall say by how much the efficiency of engines or prime movers may not be improved within the next twenty-five years? Is it impossible that within that time or, say, within the next half-century, the efficiency with which the energy in a pound of coal can be turned into electric energy may approach 60 per cent.? Should even 50 per cent. be attained, how profoundly, considering the ease with which energy can be transmitted, would such a state of things modify not merely the method of carrying on industries, but the daily life of all who live in civilized and populous communities!

Such possibilities there are in the future. The mission of electric-power supply is in any case a beneficient one, bringing health and brightness by the banishment of smoke and dirt, in addition to the positive economies and facilities it places at our doors. Much remains still to be done, but a solid groundwork has been laid and continued progress may reasonably be looked for.

MINING AND HYDRAULIC ENGINEERING IN BRAZIL.

By William Maude.[*]

The engineer in charge of the work described in the following article is a man of international reputation and of wide experience in public affairs. The work, while not heavy nor extensive in itself, is interesting on account of its peculiar and novel surroundings, which are excellently portrayed by the author.—The Editors.

A COMMUNICATION from the province of Minhas Geraes, Brazil, gives the following interesting account of engineering operations in that remote locality.

The operations were designed:—I, to supply an auriferous placer, or *cata* ("quarry") near San Gonzalo with a volume and head of water capable of breaking down and washing a bank of auriferous gravel, 50 to 100 feet in height; II, to supply an adjacent town with an equal volume of water for domestic purposes, from a different source; for the sake of avoiding repetition, only the former one of the two hydraulic operations will be described in this paper; III, to work the *cata* and extract the gold by the American hydraulic process.

The engineers to whom these operations were committed, having first made a survey and map of the locality, repaired to England, where the plans were drawn and the pipes, and other machinery and supplies needed for the works, were ordered and constructed under their directions. These materials were shipped by steamer from Southampton, while the engineers themselves proceeded to Brazil by the more expeditious route, via Bordeaux. They arrived at Rio in time to make arrangements for the prompt transportation of their ponderous material to the interior, so that when it arrived at Rio, no time was lost; it was passed by the customs officials and at once transferred to the railway, which was to carry it about half the distance to its ultimate destination. It is deemed useful to allude to these details, for the reason that engineering operations in Brazil are often ruinously delayed or entirely defeated by lack of attention to them.

At the terminus of the railway line the "machinery"—for so was it classified, invoiced, and passed at the custom-house—was transferred to bullock-carts, the only means of transportation to its destination; and as the shape and capacity of these vehicles, both of which are due to the condition of the roads, have a practical relation to all engineering operations in the interior of Brazil, it is necessary to allude briefly to them. The roads into Minhas were built in the early part of the 18th century, when the placer mines were most productive. They were of the Roman pattern, about 16 feet wide and paved with cubical stones, each weighing about a quintal, or more than twice the size and weight of those now employed in paving the great thoroughfares of New York. So long as the mines continued to remain productive—and this means productive on the basis of slave-labor—these roads were kept in repair. When this period was passed, that is to say during the latter half of the 18th century, the roads were neglected and the elements have since that time had entire control of them. The result is that the prominent portions are washed away, the depressed portions are converted into morasses, and the level portions obstructed with blocks of stones washed from above, over which obstructions nothing except a bullock-cart can be dragged, without destruction.

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[*] Translator of Humboldt's "Fluctuations of Gold," etc.

These vehicles consist of a strong platform shaped something like a mason's trowel, except that the tail does not taper to a point; the handle of the trowel representing the tongue or pole of the cart, on each side of which is yoked a powerful ox. The platform is mounted upon an axle joining two solid wooden wheels, all bound together into one piece; so that, like the mechanism of a railway carriage, the axle turns with the wheels. The latter are of course shod with iron and made as strong as possible, any breakdown upon roads destitute of smithies being equivalent to a calamity. The vehicle thus described will bear a burden of about half a ton and, when fully laden, it is usually hauled by four or six yoke of oxen. They go very slowly, making about ten to twelve miles a day, but nothing short of a precipice can stop them. The size and shape of the platform and the almost precipitous grades of the road, which the car has sometimes to surmount, determine the weight and dimensions of the load. Heavy machinery is out of question. Bulky parcels are difficult. Long ones would strike the ground in ascending. Lofty ones would strike the trees.

The *cata* to be worked was a relic of the 17th century, situated several hundred miles northwest of the capital. At the head of a valley some thirty odd miles long and six miles wide stands the town of Campanha, below which at some distance courses the river

TYPE OF WATER BOX AT THE HEAD OF THE LINE.

Sapucahy. This valley is walled in on either side by a range of mountains originally composed of granite, gneiss, ferruginous gravel, and lava, in the order named. In most places time and the elements have washed away the lava and gravel, and covered the gneiss with vegetation; the lava and gravel, both reduced almost to the fineness of powder, being redeposited below in the form of rolling hillocks, which constitute what may be termed the floor of the valley.

About midway betwen Campanha and the river, and a short distance east of San Gonzalo, these hillocks are higher than elsewhere, and form a watershed, which throws all the water on the Campanha side into the Palmella and this into the Verdi; while on the San Gonzalo side it all flows into the Sapucahy. Thus, what the mountains made into one valley, the hills have made into two valleys; and as all the material of this double valley is more or less auriferous, Campanha became a mining centre as well as San Gonzalo, though scarce-

THE PIPE LINE FOLLOWING THE BOTTOM OF A CANYON.

ly of the same importance at any time, and not nearly of equal interest at present.

The principal sources of water—without an abundance of which hydraulic mining is impracticable—are the *Mai d' Aguas* (Mother of Waters) in the Northern Sierras, and the Santa Rita, in the Southern Sierras; the former a bubbling spring of about 15 miners' inches, and the latter a cataract of 3,000 inches; the former at an altitude of 600 feet above the crest of the hill beneath which was the *cata* to be worked. This was the stream which, for reasons of expediency, it was designed to impound. Before describing this work, it may be of interest to relate the manner in which a branch of this same water was utilized by the miners of two centuries ago.

The distance on the map or horizontal distance between the spring and the *cata* does not exceed eight miles, but as the surface on this line first falls 1,800 feet and afterwards rises 1,200 feet, the water, if conveyed from one to the other in open ditches, has to

THE LINE IN A HILLY SECTION.

make a detour of nearly 30 miles, winding along the flanks of mountains and over saddles of hills, losing grade at almost every turn and finally centering near San Gonzalo, with a branch to Campanha.

Under the ancient Portuguese system of mining, the auriferous earth was not broken down by hydraulic jets, but by *cavaderas* (pikes, or lances,) and other laborious means. Hence no greater altitude was required for the ditch lines than was sufficient to conduct the water to the brow of the *cata*. The loss of grade in the ditches was therefore, unimportant. To the modern hydraulic miner, the loss of grade is of the utmost consequence. It involves either the making of new ditches at much greater altitudes (not always practicable, on account of the inferior height of some of the intermediate hills,) or else the use of iron pipes. Besides ditches, the waterworks of the Portuguese consisted of *tanges* (reservoirs) to store up the water running during the night, several of which were near San Gonzalo, with the appearance, to the unprofessional eye, of natural

PIPE LINE ON THE PLATEAU, NEAR THE TERMINUS.

lakes. The dams were covered with dense thickets and numerous trees, while the ground below the dams was raised by the debris of the surrounding *catas* and covered with vegetation. Water-fowl and edible fishes abounded in these lakes and served to conceal still further the nature of their origin.

Six series of mines—Bahu, Samambaia, Santa Cruz, Funda, Escuro, and Paciencia—comprising hundreds of separate *catas,* were opened in this vicinity during the 17th and 18th centuries; and a town naturally grew up in the midst of them, San Gonzalo being actually enclosed betwen Santa Cruz, Funda, and Escuro. Where the red and yellow banks of Santa Cruz face the spectator, he has only to walk a few steps to cross the wooden bridge which spans the ancient sluiceway of Cata Funda; while he has only to turn back a few other steps to gaze upon the abandoned opening of Cata Escuro, where captive Indians were once worked to death, and negro slaves entombed alive.

Originally, the drainage of the valley west of the watershed flowed past San Gonzalo into the Sapucahy, at a level some 50 or 60 feet below that of the town; but a century of debris so filled up the *corrego* (sluice-way) that the town now stands but little above the water, between which and its main street lies a *praira* (shore) about 200 feet wide and shelving down some 15 or 20 feet. There must have been a time when the *corrego* washed the garden walls of the houses; but since that time the water has cut its way down through the deposit of tailings and exposed some 10 or 15 feet of its numberless layers.

The ancient system of mining was either to break down the earth with long pikes, or with the series of water-holes mentioned farther on. It was then concentrated in ground sluices and the gold recovered from the concentrations by panning. There are but few evidences of flumes, sluice boxes, riffles, or the use of mercury for amalgamation. As there were no saw-mills, and hand-saws were scarce, but little lumber was cut, and that almost altogether with the axe and adze. Hence flumes and sluice boxes can hardly have been used. Yet in one place there is a mine called *Andaime,* which means a flume, and which was evidently so named because a wooden flume was employed to carry the water over a small chasm. Mercury, or quicksilver, was a government monopoly, and very costly. Iron pipes, owing to distance and the absence of railways, were out of question. These circumstances, coupled with the fact that blankets were sometimes used in the ground sluices, indicate that the miners of past ages were prevented from developing their system up to the phase of "hydraulicking," only by lack of materials and mechanical resources. On the other hand, the Indian *cautivos* (captives) only cost the price of enough food to keep them alive; while their successors, the African slaves, could be landed on the spot for, at most, $50 each. So long as human labor was comparatively costless, panning was superior to sluice boxes and mercury; and as this was the case for two centuries after the placers were discovered, it follows that but few districts known to be auriferous were abandoned, until either the best spots were washed down, or the entire vicinity was run out of grade, and so rendered valueless to anybody except the individual free panner.

Among the ancient devices for breaking down the auriferous earth was one which was used by the Romans in Northern Spain: that of cutting a ditch or sinking a line of holes along the edge of a precipice and saturating them with water until the "face" gave way and a "caving" or landslide occurred. Marks of this device can still be seen in some of the *catas* mentioned. With such primitive appliances and devices the sacrifice of human life must have been appalling, especially when we are informed, upon the authority of the Abbé Raynal, Baron von Humboldt, Dr. Southey, and Mr. Mawe. that during the two centuries of their productive period the placers of Brazil yielded no less than a thousand million dollars worth of gold. After paying the Quinto, or royalty of a fifth to the Crown, most of this treasure went to Lisbon, where the mint laws exacted another tribute from it; then it found its way, in trade, largely under the operation of the Methuen Treaty, to England, where it laid the foundation of the mint laws which distinguish the Hanoverian period.

So much for the past; now for the present. The altitude of the spring, whose waters were to be conveyed to the mine, was about 6,500 feet above sea-level. From this point, where a water box was constructed, the pipe line passed down through a rocky defile or canyon to a gravel plateau 1,800 feet below. Thence it proceeded for a distance of two or three miles upon more or less level ground to the base of a series of irregular hills, up which it had to climb to a vertical height of 1,200 feet above the plateau, to a point which will be called the Crest. At this point, the pressure of water, less friction, would amount to 600 feet. The portion designed for immediate use was to be employed 50 to 100 feet below the Crest. The net pressure at the point of discharge, leaving friction out of view, was therefore 650 to 700 feet. The total length of the line was eight miles. Through the rocky defile and until it struck gravel, the line had to be laid above ground. When it reached the plateau, and upward, in many places, until near the Crest, it was buried; in order to place it beyond the reach of accident or mischief.

The pipe line commenced in 6-inch and ended in 4-inch "steel" pipe, with screw joints. So soon as the pipe began to arrive on the ground, a difficulty presented itself which had been only partially foreseen, or provided for, in the estimates of expense. This was the necessity of clearing the timber, and building temporary roads, to enable the pipe to be conveyed to the spot upon, or under, which it was to be laid. The expense which this work involved and the time lost in executing it proved to be far more than was anticipated.

Another difficulty occurred which was entirely unforeseen; the contractors who furnished the pipe shipped a portion of it with threads cut twelve, and another portion with threads cut eleven, to the inch. As nobody imagined that such an egregious blunder was likely to be committed, the threads were not counted until the pipe was laid on the ground where it was to be put together; then it was too late to rectify it. To describe the chagrin which this discovery occasioned would be to write a serio-comedy. At first it seemed that the entire enterprise was doomed to ruin. Either the pipe joints had to be shifted, so that the 12-threads would all lie together in a continuous line and the 11-threads in a further continuous line, or else they had to be left where they had been deposited and new threads cut for innumerable joints. After a careful scrutiny of the joints, a distinguishing mark was placed upon the 12-thread joints and a consultation held on the subject, which ended in three notable measures. First, the pipe contractor was forever anathematised and excommunicated; second, a thread-cutting machine was ordered from Rio by express-post; third, the shifting of the joints was commenced. Arduous and expensive as this work proved to be, it was completed before the thread-cutter arrived; so that all the machine had to do was to cut one 12-inch thread upon an 11-inch joint. However, the cutter proved to be useful on other occasions and for other purposes. We learnt two lessons from this bit of experience: 1, count and test your threads before paying for your pipe, or ordering it to be shipped; 2, ship a thread-cutter with it.

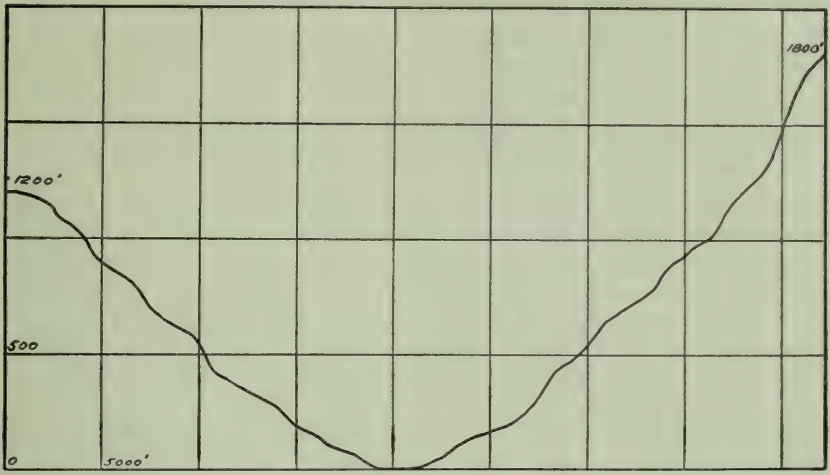
A still further difficulty which confronted the constructing engineers is worth alluding to, because it affects engineering operations not only in Brazil, but in most other countries under Roman influence. One of the engineers was informed by influential parties in Rio Janeiro that unless the local ecclesiastical authorities were propitiated, the successful working of the enterprise would be delayed or endangered. Indeed, the information went so far as to intimate that unless such propitiation took a very material form, it would be found impracticable to obtain native labor in the prosecution of the works; and that even if, in spite of this obstacle, the works were carried to completion, the undertakers would have to yield up a substantial portion of such profits as they might earn in operating the property.

Had these intimations been made before the pipe was shipped from England, it is probable that the enterprise would have been abandoned at the outset. Happily, as it turned out, the pipe was already on its way; and the only course open to the undertakers was to test the accuracy of their information by seeking an interview with the Bishop of the diocese in which the operations were to be conducted. In ten minutes' time, the whole of the bugbear depicted at Rio was dissipated into thin air. The Bishop of Campanha, a venerable priest, clothed in years and piety, so far from opposing the enterprise, willingly offered it all the support in his power. He not only disclaimed any wish or intention to impede or tax it; he declared that such a course would be both ruinous to the diocese and impracticable.

"These works," said the Bishop, "will prove a godsend to this community. They will bring to these long neglected *catas* the only power than can revive their productiveness—the power of machinery and improved methods. They will remuneratively employ a number of my parishioners, who now are idle for lack of modern tools, and indigent from the absence of industrial capital with which to erect proper works and give the people employment. As for taxing enterprises so much-needed, even were the mad desire entertained, it would be impracticable. My parishioners are Catholics; they are not slaves. They are free and independent, and very jealous of any interference with their freedom. Any attempt, either on the part of the clergy, or any other power or influence, to interfere with local industrial works, would be resented with indignation and followed by riot. Your influence with the people will be far greater than mine; and, so far from obstructing your operations, I shall take the greatest pleasure and interest in promoting them; and of this, I will afford you the strongest proofs, should you deign to invite me to be present at the installation of your works." The sincerity and goodwill of the aged priest was so evident in what he said and suggested, that all doubts on this head were at once dispelled; and, as the event proved, he not only refrained from any attempt to oppose the enterprise—he materially aided it in many ways; and the same may be said of the inferior clergy. The intimations given out at Rio, all of them from foreign sources, proved to be altogether mistaken.

For purposes of convenience, the profile of the pipe line, now presented, is drawn upon a horizontal scale of 10,000 feet to the inch and a vertical scale of 835 feet to the inch. The quantity of water conveyed by the pipe line (all that could be got at a suitable altitude and without too great expense), would, by itself, have been far too small for breaking down hard gravel or carrying on any hydraulic works that would deserve that name. But as the *catas* were composed of very fine gravel, almost destitute of stones, and as we had the assistance of the old ditch line, which, by a slight diversion was made to deliver a supplementary and copious supply of water to the Crest, the two lines of water-supply together worked with all the effect needed to keep the sluice boxes busy.

When the pipe line neared completion it was arranged to celebrate the occasion by an installation or opening ceremony and a grand lunch, to which the good Bishop and all the magnates and *fazendeiros* of the vicinity, together with their spouses, were invited.



GENERAL PROFILE OF THE PIPE LINE.
Vertical scale, 835 ft. to inch; horizontal, 10,000 ft. to inch.

For this purpose a temporary shed was erected near the *cata,* in the centre of which was placed a long table laden with refreshments. The assemblage was both curious and picturesque. First came the Bishop in a long crimson gown covered with point lace and wearing on his head a richly embroidered cap; then a stout lady in a palanquin, borne by two white mules; then numerous functionaries and planters, both on foot and horseback; many of the latter carrying their ladies behind them, *en pillion, ou coussinet de cheval.* Many of their costumes were of a period long past. It was a veritable assemblage of the middle ages, about which there was nothing to remind one of the flight of time and the appearance of modern improvements, except the long black pipe which lay upon the ground and the formidable looking nozzle or monitor at the tail of it. One had only to turn his back upon these evidences of the present, to fancy himself projected into the days of Villegagnon and the French Huguenots, whom the Admiral Coligny sent to Brazil in the 16th century.

The proceedings opened with a brief address from one of the engineers, who sketched the design and progress of the works and alluded to the hopes entertained by the proprietors that the undertaking would prove not only profitable to themselves, but also beneficial to the neighborhood. The other engineers followed in similar strains. These addresses, though warmly applauded, sank into insignificance when compared with the speech of the Bishop, and the furore it occasioned. The venerable prelate not only applauded and confirmed all that had been advanced by those who had preceeded him; he drew a strong picture of the desolation which had fallen upon the mines since their ancient abandonment, the decay of the mining towns, the neglect of the roads, and the isolation and poverty of the surrounding communities. Then, turning to the engineers, he pointed to them and to their works as the hope of the future; and entreated the assemblage to lend to them all their good-will and influence; because, to do so was to help the poor, build up the neighborhood, and supplant want and misery with prosperity and happiness. The good old man was so much affected by his own pictures of the local distress and by the fervent hope that it would be relieved through the agency of the new works, that he was melted into tears; and throwing his arms around the neck of one of the engineers, he asked him, in the name of all that was good and charitable, to open the works with his blessing. The *vivas* which greeted this outburst of feeling gave ample assurance of the approbation which the works were destined to gain from the bystanders.

At a signal which had been arranged beforehand, the water had been turned on and soon came tumbling over the Crest from the ditch line and bursting through a 1½-inch nozzle from the pipe line; the latter throwing up a magnificent *jet d'eau* and illustrating its tremendous power by undermining the *cata* and letting down vast banks of auriferous sand and gravel into the ground sluices and boxes. Upon the commencement of this exhibition the Bishop piously blessed the pipes, and the attendants chanted a hymn in which all hands joined, while some of the bystanders fired off pistols and rockets. It became a veritable *dia de festa,* a general jubilee; and nobody seemed more delighted with the performances than the aged priest, whom, it had been mistakingly feared, would bring a blight upon them.

After the monitor had been made to perform all sorts of curious antics, such as knocking down a shanty, plowing up a channel in the ground, etc., the company adjourned to the improvised banqueting hall, to discuss such good fare as the hosts were able to obtain in the neighborhood. This was as strange as the costumes and other surroundings of the occasion. Country cheese and country wine; canned kippers from England; canned butter from Italy; some ancient Spanish *bacalao* (dried cod-fish), discovered by accident in a grocer's forgotten cupboard and now served in a stew with native onions, "chili" and canned tomatoes (pronounced "perfect" by the Bishop); some English canned cakes and biscuits; and—more esteemed than anything else, at least by the gentlemen—a profuse supply of Bass' pale ale, or "pally-ally." These delicacies, together with coffee and segars, made a feast which all hands declared to be superb.

On the following day, work was commenced in earnest; and though some interruptions occurred, owing to the inexperience and awkwardness of the laborers and to some other circumstances, it was continued, until success crowned the efforts of the undertakers. One interruption to the enterprise was of so singular a character as to merit especial mention. By direction of the undertakers, wooden posts were driven into the ground around the *cata* and a rope was stretched over them, in order to secure the works from intrusion on the part of idlers. Placards were also posted up, warning such persons to keep off. On the third or fourth day after the operations commenced, a huge native, with a spear in his hand, leaped over the cordon, and made his way to the sluice boxes, which he narrowly inspected. One of the engineers, an old time Californian, immediately confronted him and pointing to the placards, requested him to withdraw. The giant with the spear thereupon drew himself up to his full height, planted the shaft of his weapon on the ground, struck a Roman attitude, and declared that as the land belonged to him, he hadn't the slightest intention to withdraw, but on the contrary, wanted to know what they were doing with "his property." This led to an altercation, in which it appeared that the giant's forefathers had formerly worked the *cata* with slave labor, and had not since then parted with their title, which now had descended to him, the man with the spear. On the other hand, the engineer showed that the *cata* belonged to the Brazilian government, which had only permitted the big man's ancestors to work it; that upon ceasing to work it, the *cata* reverted to the government, which had now accorded a like permission to the new undertakers. This permit (a formal patent in writing, conceding the right to mine) was exhibited to the interloper, with a very strong repetition of the request to withdraw. But the big man stood his ground; and it was only after some rather forcible argument that he was persuaded to betake himself and his spear to the other side of the ropes. This of course meant future trouble; and, as a means of averting it, a consultation was held between the engineers, at which it was determined, rather than run any risk of interrupting the works, to buy off the claimant; the sum of £200, in Bank of England notes, equal to 4,000 or 5,000 milreis, being appropriated for the purpose. The Californian, armed with these notes, was deputed to conduct the negotiation. On the following day, to the surprise of everybody, these two mortal foes, the man with the spear and the man who tossed him over the ropes, were seen in the village café, hobnobbing together, apparently the best of friends, one having laid aside his spear and the other his revolver. It seems that a written treaty had that day been entered into between them, by virtue of which, and in consideration of a certain sum of money, "the receipt whereof is hereby acknowledged," the native had cheerfully yielded all claims to the *cata* in dispute, as well to all other *catas* in the vicinity; and though we were burning to know what consideration had been agreed upon, we refrained for the present from interrupting so amicable and joyous a reconciliation. After the Californian had parted with his newly found friend, we all rushed into the café, anxious to learn the terms of the treaty. The information astounded us. The negociant had bought off the belligerent native for a few refreshments and the inconsiderable sum of five pounds; and he at once returned the balance into the treasury. "California style," he observed, sententiously.

One word more. It is a common error of those who know nothing of Brazil to imagine that the climate is unbearably hot, that the roads are unsafe and the natives treacherous. The facts are that after leaving the lowlands of the coast, the general level of the country being from a quarter to half a mile above sea-level, the air is pure and the climate bracing. We wore the same kind of clothing that we did in England during corresponding seasons of the year. The roads are rough, but not unsafe; while the people are so inoffensive that, after a short experience with them and barring the one contentious character alluded to herein, we never deemed it essential to carry arms.

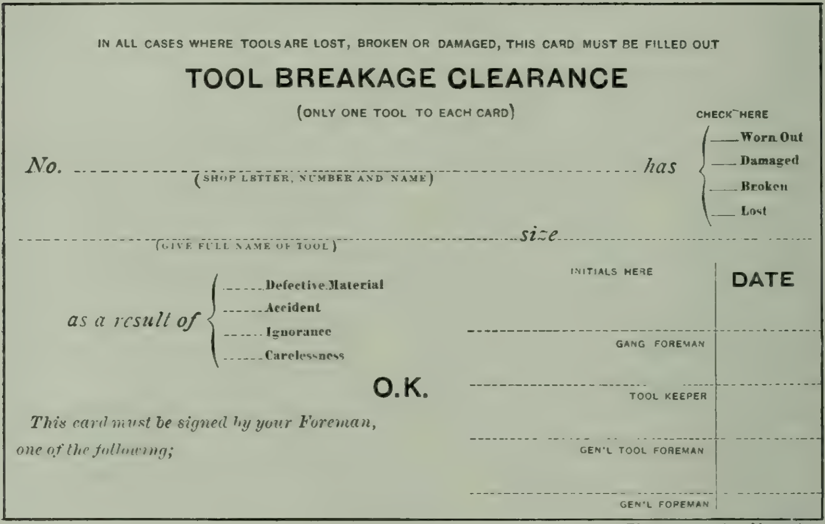
CARE AND CONTROL OF THE SMALL-TOOL EQUIPMENT IN THE SHOP.

By R. Emerson.

In our issue of December last, Mr. Emerson presented the first section of his discussion of "Tool-Room Practice for a Railway Repair Shop." In this he dealt with the general policy of standardization and organization of the tool management. Following the same general lines, he now deals with the care and upkeep of the small-tool equipment. While the experience on which his system is developed relates to the railway shop, the general ideas and special forms are adaptable to works of any kind.—The Editors.

I DO not know of any more expensive item than twist drills. These tools produce more work for their weight than any other tool, but on account of the intensity with which they are worked and the few lines in which they are unproductive (who ever heard tell of a shop that had more than enough of the commonly used sizes of twist drills?) their life is extremely short; and as the tool is not especially cheap, the amount of money annually sunk in this one item is very great—easily from a dollar to two dollars per year for every man of any kind in the mechanical or motive-power department of the road. The destruction of these tools will be the greater according as the drill work is pushed; in other words, if the drilling department should increase its efficiency 50 per cent., the destruction of drills might easily increase 150 per cent., and yet this would be true economy, because the cost of the drills in comparison to the rate per hour of the men is so small as to make the saving in wages many times overbalance the increased tool account. Although the destruction of drills is always great, and may be legitimate even when on an extensive scale, nevertheless proper methods may be devised whereby considerable savings can be effected without shortening the tool capacity. For instance, a twist drill will drill better, longer, more quickly, and more evenly if it is properly ground, and ground not only once in every few days, but, if the work on it is crowding, every hour or so.

In order to accomplish this a regular grinding department must be established in connection with the tool room, and a system whereby a dulled or burnt drill may be very quickly exchanged for one in good condition. The good drills should be constantly kept available and the dulled ones ground as fast as they come in. Not only this, but the men on the machines should be prevented from going to the grind-stone and touching up their own drills. However, it need not be insisted here that a drill ground by hand has not as perfect and efficient an edge as one turned out on a grinder. If drill work is heavy, not only will the edges give out in the natural course of events, but there will be a large proportion of absolute breakages; unless care is exercised, this proportion is apt to be too high. In order to watch this, records of breakages must be kept and it may be convenient to do this in the following manner:—



IN ALL CASES WHERE TOOLS ARE LOST, BROKEN OR DAMAGED, THIS CARD MUST BE FILLED OUT

TOOL BREAKAGE CLEARANCE

(ONLY ONE TOOL TO EACH CARD)

CHECK HERE

No. .... *has*
(SHOP LETTER, NUMBER AND NAME)

____ **Worn Out**
____ **Damaged**
____ **Broken**
____ **Lost**

.... *size* ....
(GIVE FULL NAME OF TOOL)

as a result of

...... **Defective Material**
...... **Accident**
...... **Ignorance**
...... **Carelessness**

O.K.

This card must be signed by your Foreman, one of the following;

INITIALS HERE	DATE
GANG FOREMAN	
TOOL KEEPER	
GEN'L TOOL FOREMAN	
GEN'L FOREMAN	

The Engineering Magazine.

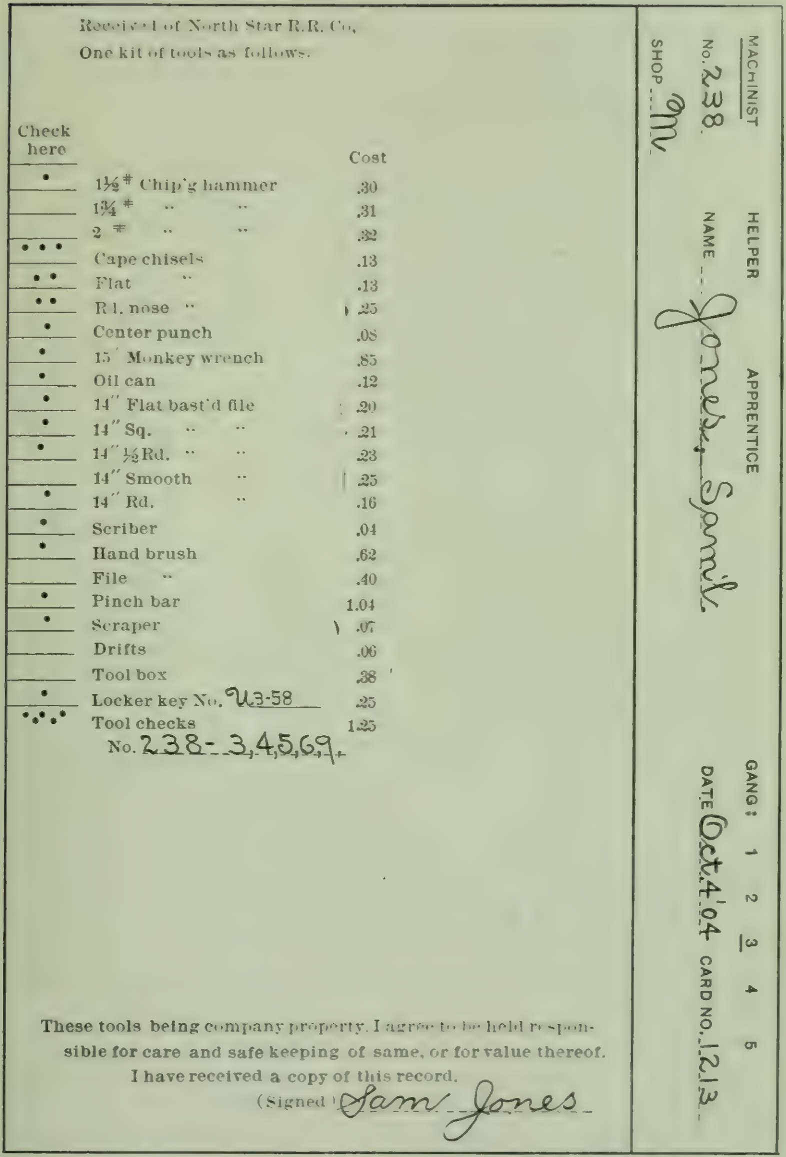
FORM OF TOOL-BREAKAGE CLEARANCE.

To be filled out by the workman, checked by foreman, and presented with the broken tool at the tool-room window as voucher for the issue of a new tool. The "clearance" forms are filed for record, and periodically examined by the tool-room foreman. The original is 6 by 4 inches in size.

To refuse to receive at the tool-room window a broken drill without a printed form being filled out giving an explanation of the cause, etc., of the breakage, this form to be checked by the man's foreman. On presentation of this with a broken tool, a new tool is issued in its place without question. The record slip is filed, and periodically the tool-room foreman goes over the collection of these slips, tabulates the results, and finds out where and how his drills are being eaten up. He is thus in a position to know not only how much money is actually destroyed in this way, but also what things are the principal cause of this destruction and where reforms may be more easily commenced. For instance, hard castings may be responsible; or, if one man is turning up too many breakages, either his ignorance or his carelessness may be at fault. Perhaps the drill is not withdrawn from its hole in the proper manner. At any rate, between the tool-room foreman and the foreman of the work where the principle destruction is taking place, some means of cutting down unnecessary breakage can certainly be devised if these men are after their jobs.

I have taken twist drills only as an example. What is true of them holds true of the other tools—reamers, taps, dies, and very especially pneumatic tools. The forms suggested in the case of twist drills can be adapted to all cases. Opposite is submitted a form for this purpose:

As has been said, the important saving of an adequate tool system lies in the convenience and hence the time of the men, so that, no matter what the wage system, more time is given to actual productive work in proportion to the total number of hours that a man is in the shop than in the case where the workman is hampered by the lack of proper tools or the difficulty of obtaining the use of them. Before the complication of modern machinery and the exacting requirements of manufacture to interchangeable standards, the varieties and sizes of hand tools were limited in number so that it was possible for a skilled mechanic to own nearly all the tools he would be required to use; and in fact he did own them, and took pride in their good condition, which consisted not so much in accuracy of size as in the maintenance of efficient cutting edges. But the modern shop, with its need of using tools and methods that will turn out the work in the least possible time, demands an outfit in sizes and styles of tools, not to speak of templets, jigs, and special devices, representing an outlay of thousands of dollars and requiring thousands of cubic feet for storage. It is manifestly impossible for each mechanic to possess such an outfit containing all the tools he will have frequent need of. Under the old conditions the men pieced out their own equipment by borrowing from their fellows where they had special requirements. At the present time this borrowing is done in large measure from a sort of clearing house—the company tool room. We have, then, three systems existing side-by-side—the individual tool kit, the mechanic's personal property; the loaning of special tools from man to man; and the loaning by the company of high-priced tools for the production of standard sizes in work. There are great advantages in ownership of the tools by the shop; first, in the reduced number of tools required, the tool stores, with an efficient checking and return system, being but a balance in bank to be drawn on from the locality where stringency occurs; second, in the ability to obtain exact standards; third, in the power given the shop management to dictate in detail each process of doing work, by placing the tools conveniently to the work; and fourth—connected closely with third—by the fact that the workman's wage represents the interest on a smaller capitalized investment—that the man is cheaper and that his output is more closely regulated. It has therefore become the custom in many of our larger and newer shops, not only to supply a company tool-room, but also to furnish to each man such of the simplest tools as it is indispensable he shuld have at hand at all times—hand and cape chisels, hand hammer, files, monkey wrench, center punch, oil can. In less well regulated establishments the man secures these tools as best he may after he enters the company employ, "borrowing" (and keeping) them whenever he has opportunity, and jealously guarding such as he captures, on account of the difficulty of obtaining more; in other shops with more system, the man is required to make a deposit or sign a statement guaranteeing payment in cash to the company for such tools as are lost, a check being maintained on extravagance in this way. Of course, each department of the shop will have somewhat different tool needs, and so the tool kit will vary, the boiler-maker requiring, in addition to the above small list, drifts, calking tools, riveting hammer, and tool box to take with him into the boiler; a machinist will need a large complement of files, a soft hammer, scriber, and several "S" wrenches; a tinner, snips, soldering coppers, pliers, solid punches, square, mallet. It will be found that the cheapest and most efficient way of looking after these tool-kits is to establish at the outset a thorough system providing for all cases with as few exceptions as possible. I shall give an outline of such a system, together with the forms and records used and the way of looking after it. Each man as he enters the employ of the shop is provided with an individual kit of tools such as are needed in the department of the shop where he is to work, kits being uniform within a department; he is provided with a drawer, locker, or cupboard, in which to keep these tools, such storage place being convenient to his work, being made preferably of steel netting for ready inspection, and being provided with a *good* lock of which the tool-room foreman has a master key or duplicate. For all these, key included, a man signs a printed statement that he will return them or their value on quitting the company's service. It is a great practical convenience to have this form confined to a card not over 4 by 6 inches, this last including all the tools that are usually assigned to kits, with blank spaces for extra ones, the tools that are given out in any case being ticked off after each item. It is well also to indicate the cost price of each tool on the face so that a man may know the extent to which he is liable.



Received of North Star R.R. Co,
One kit of tools as follows.

Check here		Cost
•	1½# Chip'g hammer	.30
	1¾# " "	.31
	2 # " "	.32
• • •	Cape chisels	.13
• •	Flat "	.13
• •	R l. nose "	.25
•	Center punch	.08
•	15' Monkey wrench	.85
•	Oil can	.12
•	14" Flat bast'd file	.20
•	14" Sq. " "	.21
•	14" ½Rd. " "	.23
	14" Smooth "	.25
•	14" Rd. "	.16
•	Scriber	.04
•	Hand brush	.62
	File "	.40
•	Pinch bar	1.04
•	Scraper	.07
	Drifts	.06
	Tool box	.38
•	Locker key No. U3-58	.25
• • • • •	Tool checks No. 238-3,4,5,6,9.	1.25

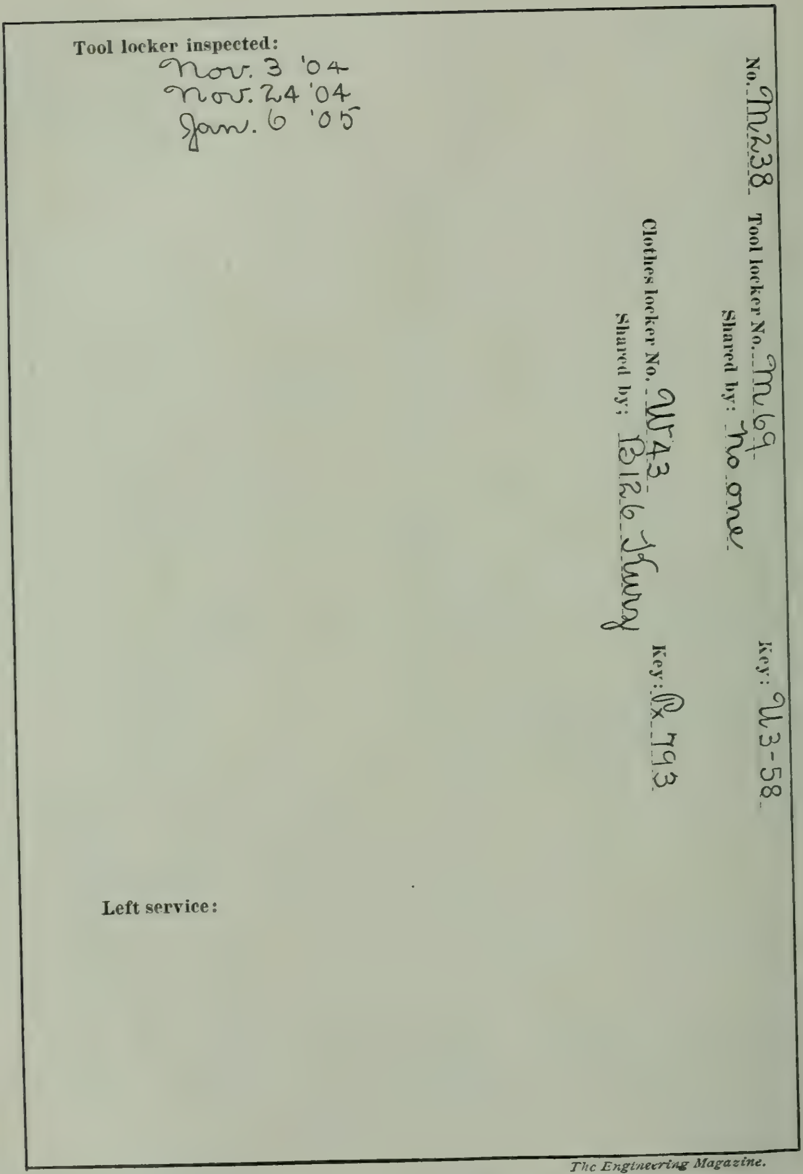
These tools being company property, I agree to be held responsible for care and safe keeping of same, or for value thereof.
I have received a copy of this record.
(Signed) Sam Jones

[✓ MACHINIST] HELPER APPRENTICE
No. 238. NAME Jones, Sam'l.
SHOP Mv
GANG: 1 2 [✓ 3] 4 5
DATE Oct. 4 '04 CARD NO. 1213

The Engineering Magazine.

WORKMAN'S RECEIPT FORM FOR TOOL KIT, AS FILLED OUT.

The form—preferably on a card, 4 by 6 inches—is filled out in duplicate, original and duplicate being signed by the workman. He keeps one copy and the other is filed in the office. The mode is explained in fuller detail on page 799. The back of the card is shown on page 798.



Tool locker inspected:
Nov. 3 '04
Nov. 24 '04
Jan. 6 '05

No. M238 **Tool locker No.** M69 **Key:** W3-58
Shared by: no one

Clothes locker No. W43 **Key:** Rx 793
Shared by: B126 Henry

Left service:

The Engineering Magazine.

BACK OF TOOL-KIT RECEIPT FORM.

The face of the form is shown on the preceding page. The entries here complete the current record of the kit in question, and complete the history when it is finally turned in on the workman's departure from the service.

In order that no opportunity may be given for the man to claim improper charging, it is well to have the list made out in carbon duplicate of which the man is given the original. This may be conveniently done in the following manner:—the cards are blocked in pads (gummed on one edge only, and that at the bottom) and are alternated with printed duplicates of thin paper. Cards and duplicates are serially numbered by machine, the card and its duplicate having of course the same number. Of these two the thin-paper sheet is the original. A carbon paper is slipped between it and the card, and an indelible pencil is used to write in the date, number of each kind of tool, names of extra tools, and the man's name at the top of the card where it will be legible and convenient for reference when filed in a case. The tools are ticked off by using a sharp-pointed instrument which will perforate the original thin slip, and yet not go through the duplicate card. The man signs his name in ink to both the original and the card. The original is given over to the man's possession, it being in such shape that he could not readily alter it without detection, and the card duplicate is placed on file in the main tool-room office. When a man leaves, the kit of tools he turns in is compared with this list, deduction being made for what is missing. So much for this record, which has many additional uses—for instance, as a running inventory of the value of equipment tied up in this way in small tools. On this slip also, six to ten tool checks are signed for, the number usually being fixed in a given department. These of course are for exchange at the tool-room window for special tools not included in the kit, such as taps, drills, gauges, etc. The checks should not be made as usual of sheet brass cut out and stamped in the shop, but should be made either of brass, or preferably aluminum, imprinted by a special die with the company's name, and numbered by means of an odd size and shape of steel figure which can not by any chance be duplicated by the shop men. In addition to this it would be well if all checks were numbered serially on the back. This can be cheaply done by machine if the checks are bought originally from some one of the large concerns making a specialty of them. Of course, a great many blanks (also serially numbered) are bought at the same time to provide for shop increase and checks that are lost. But the serial number makes possible an absolute record of every check given out, and in connection with a locked tool-room, and the signed slips for tool kits, not only renders the possibility of fraud remote, but also in a very substantial manner reduces the necessary annual investment in small tools. In a locomotive shop employing

1,200 men, where such a system was installed, over $600 per month was saved in money expended for small tools alone, above the expense characterizing the period when such records were not kept.

It is not sufficient to establish this system of individual tool kits with places for storage and to provide an efficient and definite means of checking from the tool-room. The system must be kept up in both cases, and means for doing so provided. While in theory it is excellent to have all tools returned to the tool-room at least once a week, in practice this will usually be found difficult, and the aim of this frequent tool-room supervision of tools will be attained if only the more important and scarcer tools are watched in this way, and the rest permitted to remain out until the man finds he needs to get other tools on the same checks. In order to avoid, however, the accumulation in men's lockers not only of tool-room tools, but of tools "borrowed" (by stealth) from fellow employees, or picked up about the shop, a regular inspection of tool lockers is essential. I have used for this purpose a young helper who would go about with his duplicate and master keys (record of the style and key number being kept on the same card with the list of the tool kit), after hours, nights and Sundays, checking up the tool kits assigned with the tool kits on hand, and also with the tools drawn from the tool-room. In this way any loss or breakage or "borrowing," or too long detention from the tool-room of tools often needed is detected, and the man is called to account the following morning by his foreman, at the instance of the tool-room foreman. Such a man, earning about $35 a month, was able to check over 800 men once a month, at the same time attending to the matter of providing tool kits for all new comers and checking up and furnishing clearances for all employees leaving the service.

I have tried numerous tool-checking methods; writing out a separate card each time a tool is drawn, the card being destroyed when the tool is returned; the book record, in which the man's name and the tools taken are noted on each occasion; the slate, a similar record wherein the notation is erased on the tool's return, or where each kind of tool is given a column, heading and lines being painted in white and the names of the men drawing each class of tools being entered in the respective places; the plain check system, by which a certain number of checks are alotted to each man on entering the shop employ, these checks being given to the tool-room in exchange for tools and placed on the shelf normally occupied by the tool; a modification of this system, similar to the modified slate record, wherein a large board at the tool-room window is arranged with hooks or pegs corresponding to the different varieties and sizes of tools, the checks being hung on the hooks instead of being promiscuously scattered in the tool-room; and lastly, the double-check system, in which not only each man has a check, but also each tool, a check-board being provided at the tool window arranged according to the shop numbers of the men, for the accommodation of the checks belonging to the tools, the men's checks being hung on hooks placed by the location of the tools in their shelves or their pigeon holes. The last named system was found to be most exact when special care was needed to fix definitely the location of important tools, but was found too cumbersome in installation (though not in operation), for application to the general run of tools in a large tool-room, and was used, therefore, with success simply in the case of pneumatic tools, special taps and reamers, templets, gauges, and high-speed machine tools. The checks for the tools in question were made of metal pasted over with paper, on which was rubber-stamped the name of the tool, with indication of size and serial number, the tools in this case being stamped with such numbers on the soft shank. The face of the check was then gone over with shellac.

Most railroads keep a book or card record of repair costs to each locomotive. The reasons which justify this also justify a similar record in the case of machine tools. The card form of this record is the most convenient; and where it is kept by a general tool supervisor or foreman, or his clerk, it may conveniently include in its scope air motors and all the more expensive and special tools and jigs—say everything costing above $10. There will be one card for each machine tool, hand tool, or jig; first cost, and each item of repair or other charge, being entered on the card. Special tools, such as piston extractors, templets, and jigs, should be catalogued, and very definitely described, so that at any time in referring to this list it would be known just what standards were available. Sketches should be made in this catalogue so as to make the inscription entirely clear. For the smaller tools in the shop, even down to hand chisels, cards should also be kept, but for groups rather than for individual tools—a card for each size of drill, or reamer, or tap, a card for flat chisels, a card for each style of file. This tool record, it will be readily seen, in connection with the card record of men's tool kits, furnishes a running inventory, available at all times, of all tool equipment whatsoever; and the records kept in this manner, if summed up into classified statements (which may be very readily done), furnish a very valuable review of this account, and the guide to the more costly avenues of tool expenditure, showing where the promise of savings would be largest with a given amount of attention. Not only this, but tools on requisition, those on the card inventory, and those accounted for by the tool-breakage clearances, should furnish reciprocal checks.

Many shop superintendents will be alarmed at the prospect of employing not one, but half a dozen to a dozen extra men for supervising and maintaining a thoroughly effective tool system; but it must be remembered that the wages of a few cheap men (and old men are often very careful in such matters) are a small item compared to the time and money saved to the mechanics. And such a system unquestionably means this saving of time, for it sees that each man is provided with the tools he most needs, with the least possible investment as a whole in hand tools by the company, and at the same time makes the interchange between tool-room tools and men so prompt that there is not the necessity of having to inform the man that certain tools are "out," or forcing him to spend half an hour wandering around finding a man who has what he wants. And men are encouraged to take some care of their own kits because of the company's efforts to prevent the habitual practice of stealing from one man by another.

I once worked in a shop where it was required to return special tools and gauges on the same day they were taken out, or as soon as the job was finished on that day. This system, while economical in the total number of tools required, was very costly—not only in the frequent running to and fro with tools, but also from the fact that because of the fewness of the tools, many and vexatious delays in getting work done were caused.

The problem of properly serving the men with tools cannot be solved by dogmatic rule, but must be worked out to fit the needs of each shop. In the case of a large railroad shop the following arrangement will usually be found satisfactory:—there will be one central tool-storage room, not necessarily (indeed, preferably otherwise) in connection with the manufacturing tool-room; from this central room all distribution of tool supplies will be made; then for each shop or department there is a smaller tool-room, set of shelves, or rack, containing the tools most used in that branch of the work, these sub-tool rooms being managed by the foreman himself (near his desk) or by a boy; then such tools as are needed from the main tool-room are called for by telephone (supposing each foreman to have an instrument at his desk, as should be the case in any well regulated and modern establishment of any size), this main tool-room having a number of errand boys for the purpose of delivery. Where the shop is on more than one floor dumb-waiters may be used with great success. One may go too far, however, in attempting a system of this kind, such, for instance, having been the case where a tool-room in a large shop was equipped with an elaborate annunciator system. In the first place, the arrangement was continually out of order; the cranes jarred down most of the pointers every time they passed over the tool-room; the influence of the heavy electric power circuits played havoc in cross currents; and even when the system was in successful operation it was not economical, since the workman had to wait for a call boy to respond to his rings, then had to give his order, and finally —got the wrong tool.

Large wrenches and tools usually used on the erecting floor should be as rigorously cared for as the cutting tools furnished from the tool-room. Unless this is done (that is, unless they are checked out and returned to their proper places in a systematic manner) there will be constant difficulty and friction resulting from the mislaying of these tools. I have sometimes seen wrenches, etc., being carted off and dumped on the scrap pile by the sweepers, whose duty it was to clean up the shop Saturday night, and on Monday morning the men would be howling around and complaining that they could not get tools to do their work.

Among the lesser helps to efficient tool-room management may be mentioned not only the systematic grinding of twist drills, but also the maintenance of a plentiful stock of flat and cape chisels. Similarly with drift pins. Also the matter of promptly rehandling hammers should receive attention. Of course all broken tools should be exchangeable, after satisfactory explanation, for new. The tool-breakage clearance is referred to elsewhere.

Broadly speaking, the economies that may be brought about in the very first year, by an intelligent analysis of tool conditions, and energetic introduction of method, will be surprising—will seem incredible to those who have not studied actual cases closely. Spending money on *men*, andon the best tools, is one of the wisest forms of retrenchment.

THE WORK OF THE COMMISSION ON THE PANAMA CANAL.

By C. E. Grunsky,
Member of the Isthmian Canal Commission.

Mr. Grunsky's paper was originally prepared as an address; under the auspices of Admiral Walker, chairman of the Isthmian Canal Commission, it has been given exclusively to THE ENGINEERING MAGAZINE for publication. Its importance will be recognized, as it is a direct, authoritative statement of the work accomplished and the general policy and methods of the Commission in dealing with the construction of the canal. It gives to the professional and commercial public interested in the progress of the work the best idea obtainable at present of the actual conditions and the immediate prospects of the undertaking.—THE EDITORS.

PERHAPS no great work was ever undertaken by any nation which came so near receiving unanimous approval of all the people as the construction of a canal by the United States connecting the Atlantic and Pacific Oceans.

The oceans are separated by a strip of land which, as the crow flies, is at some points less than 40 miles wide. Ever since the discovery of the Pacific by Vasco Nunez de Balboa, in 1513, it has been the dream of adventurers, of scientists, of civil engineers, of emperors, and of nations, to see the union of the oceans at or near Panama an accomplished fact.

That conditions for the carrying out of the enterprise were not ideal is too well known to need comment, but in view of the many failures to accomplish any result beyond ascertaining what physical difficulties had been interposed by Nature, it is natural that the difficulties should ordinarily be considered much greater than they really are. The Isthmus has been made to appear as a land unlike any other part of the globe; something unreal, uncanny is made to pervade the very atmosphere, so that many who go there for business, or pleasure, are for weeks oppressed by a fear of they know not what and do not breathe easily until they get that famous view of "Colon" from the deck of a steamer bound for New York.

The stories of pestilence and death during the migration across the Isthmus while the great California gold excitement was at its height, during the building of the railroad, and again during the period of great activity under the old Panama Canal Company, are greatly exaggerated; but they have left their impression upon the public mind and it will take time to correct this impression.

The properties of the Panama Canal Company were taken over by the United States, on May 4, 1904. There were at that time about 600 laborers at work in the cut through the Continental Divide at Culebra, and the floating equipment, machinery out of use, buildings, and vast accumulation of material, were in charge of care takers.

The progress being made was not commensurate with the magnitude of the enterprise. The construction work appeared rather to be done to hold valid the concessions, than with an earnest effort at real execution. And this was quite natural. Had not the American people determined that they must have a canal? And whether at Panama or elsewhere, what need of increased effort? A location elsewhere than at Panama of an American canal would destroy the hope that a privately owned canal at Panama could be made a financial success. The French company had really no option; it had to accept what the United States was willing to give. The work it had done on the canal was only worth what the United States would pay for it, and an offer from the United States, it was easy to see, would not be affected by an increased rate of progress on the construction work. And so it was that no effort had been put forth for some years to improve methods of work or to increase the rate of progress. A thousand yards of excavation per day, less than 3,000,000 cubic yards in three years, was the output; and this was accomplished largely by pick and shovel methods. The Canal Company's work was under the management of a director-general, who was assisted by a meager staff of engineering and clerical employes.

The extensive hospital buildings at Ancon were in charge of a single physician, who, aided by a number of sisters of the Order of St. Vincent de Paul, cared for a few patients that were only inadequately provided for, and for a small number of orphans. All of the hospital buildings were sadly neglected, needing repair, and the grounds were overgrown with shrubs and weeds. A second Canal Company's hospital at Colon had practically gone out of use. A part of the main structure had succumbed to the force of a gale, and a few sick people, mainly members of the police force, were being cared for by the self-sacrificing sisters of the Order of St. Vincent de Paul to the best of their ability.

The members of the Commission, upon organizing in March, 1904, determined that an immediate examination on the ground was necessary in order that all members might be thoroughly familiar with conditions there prevailing, and to give those of its members who had not before studied the canal problems an opportunity to acquaint themselves with these problems and with the physical and other obstacles that would have to be overcome in the canal construction work. This visit to the Isthmus preceded the taking over of the canal properties, but was fruitful in its results. The Commission found that it would be necessary, as soon as the United States entered into possession, to make additional special engineering studies and examinations of a number of problems of which the more important were the following:—

A special examination, with borings, at a dam site on the Chagres River at Gamboa, together with surveys covering certain indicated localities between the Chagres River and the Pacific Ocean to determine the feasibility of at least a partial diversion of Chagres floods to the Pacific slope.

An examination with borings at the Bohio dam site to supplement data heretofore collected by the Canal Company and by the former Canal Commission.

An examination with borings at Gatun to determine whether it would be feasible to erect across the valley of the Chagres, at that point on one of several possible locations, a dam sufficiently high to bring the summit level of the canal as far down stream as Gatun.

An examination with borings along an alternate canal location at Tiger Hill between Bohio and Gatun.

An examination, with surveys and borings, of portions of Limon Bay and adjacent country to serve in planning the Atlantic terminal of the canal, and the interior harbor which is there to be provided.

Also special examinations to determine the available source of water supply for the cities of Panama and Colon.

For this work of investigation, parties were organized as soon as the Commission was back in the United States. In charge of four assistant engineers the studies were commenced within a few weeks after taking possession of the canal properties.

Meanwhile the Commission had been considering the selection of an engineer who could be placed upon the Isthmus as the executive officer of the Commission in charge of the canal construction work. This choice fell, as is well known, upon a member and past president of the American Society of Civil Engineers, Mr. J. F. Wallace, whose large experience in railroad work and in the arrangement and direction of transportation facilities, and whose great executive ability, seemed to indicate him as specially qualified for the position. No change was made in the Commission's plans when he entered upon his duties in June. The Commission has continued the investigations above indicated, placing them under his direction; and hopes that within a few months the data will be at hand that will enable the Commission to cope with and to reach a conclusion on the main question as to the type of the canal.

The question is often asked:—"Has not this matter of the elevation of the summit section of the Canal been already settled by the last Isthmian Canal Commission, and by the action of Congress in appropriating $145,000,000 for the purpose of the work?" It should be remembered in this connection, that the last Commission carried its investigations far enough to justify its conclusion that a canal could be built; that in the light of the available data, the project that was tentatively adopted and described appeared the best; and that on the basis of assumed unit prices, its estimated cost would be as reported. A comparison with other canal routes was thus made possible, but the question was not settled whether or not the best project was this particular one with the canal summit level at 85 feet above the sea. The present Commission would not be performing its duty fully if it did not place itself in possession of the information necessary to determine whether the summit section of the canal should not be at 60 feet instead of over 80; and if this alternative is to be analyzed, then why not know whether, everything considered, the canal should not have a still lower summit section, or possibly be constructed at sea level? In reaching a conclusion on these points the question of feasibility of carrying out the work is not the only one of moment; the cost of the work must be taken into account, and cost of operation and maintenance after construction; the time required to complete the canal; the advantages and disadvantages of each type to shipping interests; and also the degree of risk involved in the maintenance of the works. That the element of risk is not all in favor of the canal which is free from locks will at once be realized by every engineer who visits the points of maximum cut, noting the shattered and unstable formation, where landslides, if occuring, might seriously and for long periods of time impede traffic, and where the magnitude and seriousness of such an obstruction, and consequent interruption of traffic, should it ever occur, must be assumed to grow with the depth of the cut.

Sufficient information to justify a final conclusion as to type of canal was not collected by the old or the new Panama Canal Companies, nor was it collected by the last Isthmian Canal Commission. It was not required by the former, owing, in the main, to the fact that theirs very soon became a problem to construct a canal as a concessionary within a fixed time limit, and of such a character, of such a size, and at such a cost, that it would be a paying investment. Theirs became a plan for a canal with a bottom width of about 100 feet and with a summit level at about 65 feet, to pass vessels with a draft of about 29 feet. When these canal dimensions are compared with those suggested by the last Commission, and which also remain subject to modification (being a bottom width of 150 feet and at least 35 feet of water—and there is now no other time limit nor limit of cost than such as can be justified by considering all circumstances) it must at once be apparent that the Commission is dealing with a new problem and cannot enter upon large contract work until the canal to be built shall have been designed.

The investigations of the last Commission, as already stated, were carried far enough on the line of the Panama Canal to serve a specific purpose. They were not, as a matter of course, intended to furnish the information required in making final plans of the work. They are good as far as they go, and they are being supplemented by the work that has now been in progress, as indicated, for seven months.

The borings which the Commission has made at Gamboa indicate that there will be no difficulty in securing a good foundation for a dam across Chagres River at that point. As this fact had been indicated by the examinations made by the French engineers, no other result was expected. It is quite probable that the Commission will see its way clear to the erection of an earth dam of huge dimensions at this point. There is no reason why this locality should not be made one of the spoil banks for the material requiring transportation on cars. Assuming that this dam will be built, instead of the one which has been considered as an alternative at Alhajuela, and that its crest will be carried to an elevation of about 200 feet above sea level, there would be created above it a lake with a surface extent of about 30 square miles, the rise and fall of which would prove a great equalizer of the flow of Chagres River, and—making the diversion of a portion of this river's flood flow to the Pacific slope feasible—this would go far toward so reducing the amount of water to be handled in the canal that its flow would not seriously impede the passage of vessels in a sea-level canal.

It should be stated that this matter of a diversion of Chagres River to the Pacific Ocean was also studied by the French engineers, and that the new information obtained by the Commission relates mainly to the complete exploration of a dam site to determine position of bed rock, and to the measurement of the length of a tunnel, at an elevation of about 175 feet above the sea, from the valley of the Chagres to a stream flowing into the Pacific Ocean. This tunnel length in the location examined would be between seven and eight miles.

As soon as a definite program could be agreed upon, purchase was made of 14 modern steam shovels, some of which are already at work, and of which the last will reach the Isthmus within six months. These are being put to work as rapidly as the ground can be prepared to receive them, each one adding about 1,000 cubic yards per day to the output. This excavating plant will be supplemented by car unloaders and bank spreaders, which have already been purchased, and, in fact, by every labor-saving device that can be employed to advantage, it being self-evident that where conditions are not favorable for labor, this should be replaced by machinery to the maximum extent possible. The use of machinery and labor-saving devices will not only be of direct benefit in expediting the work, but of indirect benefit as well, by reducing the number of employes and consequently the sickness, loss of life, and attendant cost.

Careful records will be preserved to determine the unit cost of excavation, and of the delivery of material to the spoil banks. The excavation work will be continued with a steadily increasing force during the time that plans are being made on the basis of which contracts can later be awarded.

The Commission will thus be in possession of facts, before awarding large contracts, relating to the efficiency of appliances and of labor operating under the local conditions, that will be of great service to contractors in submitting proposals; and that will also be a valuable guide in determining whether proposals are reasonable or not.

The Commission is at present engaged upon the preparation of specifications for a dredge of modern design, with which harbor dredging and canal work near Colon are to be undertaken.

It is self evident that any modern plant, used by the United States in the canal construction work preceding the letting out of the work by contract, can be turned over to contractors in case that contracts are awarded. The United States would, in such event, receive the full benefit of the value of any machinery turned over. Meanwhile, all of the work done with any plant now purchased is useful work, and brings nearer the date of the completion of the canal.

The Commission's work has extended into other fields besides the collection of engineering data and a study of engineering problems and construction work. It has organized a sanitary department whose main duty is, and the Commission hopes will ever continue to be, to prevent the spread of disease, to prevent epidemics of contagious and infectious diseases, and to make and maintain the Isthmus a healthful region. This work is carried on with a thoroughly organized staff, including a board of health, sanitary officers at Panama and Colon—where the United States may prescribe health regulations and, local authorities failing, enforce the same; a sanitary service for the Canal Zone, maritime quarantine service at Colon and Panama and the Canal ports, besides the necessary hospital service.

The employes of the Commission are given free medical treatment and care at hospitals, of which the main one at Ancon is in full operation and a second one at Colon is being repaired and enlarged. Besides these hospitals there are emergency hospitals and dispensaries along the line of the canal.

The health-department organization is such throughout that it is capable of expansion as occasion may arise. Even as at present organized the expenditures by the health department, including the work of sanitation, such as draining or oiling ponds, covering water containers, abating nuisances, removing waste and night soil, will probably pass the $1,000,000 mark before the close of the current fiscal year and will thereafter be in the neighborhood of $800,000 per year. This large expenditure is justified because by such measures as are being taken the Isthmus will unquestionably be made and kept as healthful as any country similarly situated, having similar climatic conditions.

In the matter of making purchases the Commission is not as favorably circumstanced as would be a board of directors of a large corporation, which the Commission somewhat resembles. Its work, being a national enterprise, makes it imperative that so far as practicable every section of the commonwealth, manufacturers and merchants throughout the land, should be given equal opportunities to furnish machinery, materials, and supplies for the use of the Commission. This means competitive bidding, so far as competitive bidding can be made practicable, and the award to lowest and best bidders. The Commission recognizes this fact and has acted accordingly. It has adhered to this principle, even in many cases when the difficulties of ascertaining the merits of the individual proposals were great and when this method of purchase was the cause of much annoying delay. It has resulted, however, in the distribution of the purchases thus far made to widely scattered sections of the United States.

The members of the Commission are directors of the Panama Railroad Company which, in addition to the trans-isthmian railroad, operates a line of steamers sailing weekly from New York to Colon. The railroad company owns three steamers and charters others as required. Sixty-nine seventieths of the stock of the Panama Railroad Company is now the property of the United States, having been acquired as part of the property transferred by the Panama Canal Company.

The territory over which the jurisdiction of the United States has been extended on the Isthmus, though small, having an area of only about 450 square miles, requires the same attention in the matter of suitable government as though it were of much larger extent. Coupled with this is the fact that the Canal Zone is not a productive area, and that any system of taxation that would make the government of the zone self-supporting would be burdensome. The Canal Zone government will probably never be entirely supported by local revenues. In organizing a government of the zone, the Commission has enacted laws establishing a judiciary, providing for municipalities and their government, prohibiting lotteries and gambling, establishing an executive department; besides enacting a penal code and a code of criminal procedure. The Commission has also given its sanitary rules and regulations the force of law, and has prescribed the sanitary regulations which are to be put into force by the Republic of Panama and Colon.

During the progress of the canal work practically the entire population of the Canal Zone will, directly or indirectly, be dependent upon the canal work for its support. The use and rental or possible sale of public lands will be regulated with proper regard for canal requirements; all business affairs and enterprises of every character must be so regulated as to be properly co-ordinated to the operations of canal construction.

In short, the Canal Zone Government, the canal construction work, the sanitation work, and the operation of the railroad which parallels the canal, which must be kept in uninterrupted service for the transit of merchandise over the Isthmus and which is an invaluable aid to the canal construction work, must all be under the direction and control of the same managing body.

The Commission transacts its business at stated and special meetings which are generally held either at Washington or on the Isthmus; rarely elsewhere. During the period of organization and the study of the canal projects, its work, as a Commission, has been mainly at Washington, its affairs on the Isthmus being directed through its executive officers there stationed. Its duties have in a measure been subdivided, questions of importance being referred to its standing committees of which there are six:—the executive committee; the committee on engineering; the committee on finance; the committee on legislation; the committee on sanitation; and the committee on engineering plans, which last is made up of the engineer members of the Commission, the chairman being ex-officio a member of all committees. The governor of the Canal Zone is a member of each committee when meetings are held on the Isthmus.

It is proposed so far as practicable to have the committees follow each other to the Isthmus, thereby keeping three members of the Commission in close touch with its executive officers in charge of construction, sanitation, and the government of the Canal Zone. No one can visit the Canal Zone at the present time without being impressed with the orderly conduct of the work in the several departments created by the Commission.

The government of the Canal Zone, with an executive branch, a judiciary, a department for the collection of revenues, a postoffice, a police force, and the like, has one of the members of the Commission at its head. Nominally the health department has been made a part of the executive branch of the Canal Zone government, although its duties are by no means confined to the sanitation of the Canal Zone, and its affairs need and receive the supervision of the Commission.

The material and supplies department has been put in charge of the machinery, material, and supplies that will be required and handled on the Isthmus. A special board of appraisers is listing and appraising the value of all machinery and material turned over by the Canal Company, which, to the greatest extent possible, will be made use of in the canal construction work. This property stood upon the books of the Canal Company at nearly $30,000,000; its actual value, however, though considerable, and more than was at first expected, is only a small fraction of this amount.

The engineering department has charge of all construction work, and of engineering investigations.

It may be of interest to note that the abundance of clay and other light material to be excavated in making the great cut at Culebra prompted the Commission to have a special examination made by an expert in hydraulic mining methods, and that his conclusions indicate a possible alternative method of doing a large part of the required work at this point.

The construction work of the French Company has been continued without interruption; but American methods of doing work and American machinery, as already stated, are being introduced as rapidly as possible. Laborers in large numbers have not been sent to the Isthmus because the time for any considerable increase of force has not come. Not only is the question of type of canal to be settled before an adequate distribution of a large working force can be made, but time is required to prepare the Isthmus for a large influx of canal employes. Neither material nor artisans have been so quickly available that suitable quarters could be provided as rapidly as the Commission desired. The Commission is not yet in position to furnish quarters to all of its employes now on the Isthmus, and some additional time must elapse before this can be done. It takes time to select sites for buildings, to construct water works and sewer systems, and to effect land purchases and purchases of material, and to erect structures. These matters are all receiving attention, but in the meanwhile the staff of employes can not be indefinitely increased. It should be added that the Commission has constantly discouraged the taking of families to the Isthmus in advance of the completion of the preparations for its employes, on which, at present, the Commission is most active.

There are now on the Isthmus in the employ of the Canal Commission and in the employ of the Canal Zone government, about 3,600 people. The sickness among these employes has averaged about 3 per cent.

Neither Panama nor Colon is an inviting place for residence. Neither of these cities has a water supply; neither of them has a sewerage system. Under the treaty with the Republic of Panama the United States is authorized to construct water works and sewerage systems for these cities, recovering their cost in a long series of years. The Commission took immediate action in these matters, planned water works for Panama and a sewer system; has bought the material for the same and is pushing the work of construction as rapidly as circumstances permit.

The combined cost of water works and sewers for Panama will be in the neighborhood of $750,000. Similar work for Colon is not as far advanced, there being some special problems involved in that city. It may even be found desirable to raise the ground surface of Manzanillo Island, on which Colon is located, before constructing the sewer system.

When a high dam has been constructed across Chagres River, either at Gamboa or at Alhajuela, the vast lake thereby created will afford an excellent source of water for domestic use and will, without doubt, be the ultimate source of supply for the entire Canal Zone and the two cities, Panama and Colon.

It may also be stated, in passing, that either of the dams mentioned, while furnishing water for canal purposes, will yield abundant water power which, by electrical transmission, will become available along the entire length of the canal. It is easy to foresee that the power and electricity thus generated will add to the comforts and conveniences of the inhabitants of the zone and will become valuable aids to the canal construction, and subsequently in the operation of the canal as well as in the operation of the railroad.

It should be added that the affairs of the Commission thus briefly outlined must necessarily involve the receiving and disbursing of large sums of money. Suitable provision has been made for a proper classification of expenditures, and for such supervision, control, and inspection that misappropriation or embezzlement of public moneys cannot escape detection, and so far as check systems and supervision can accomplish this, will be prevented.

The total disbursements of the Commission to the close of the year 1904 have been $1,060,000. The purchases to date, including some not yet delivered and paid for, aggregate $888,700.

The progress made to date has been reasonable, but neither it nor the work of the next few years can or should be measured merely by cubic yards of excavation.

Whether Congress in its wisdom permits the great work to be carried on under the management and direction and according to canal plans designed and recommended by the present Commission, or whether some other plan of management, control, and design be adopted, the American people may rest assured that American directness of methods, American energy, American engineering skill and resourcefulness, will make the canal work just as certain of accomplishment as though the Isthmus were located in our temperate climate, close at hand, instead of at a distance in the tropics. The work will be done; it must and will be well and honestly done.

EDITORIAL COMMENT

TO many earnest friends it may be a disappointment that in the article upon the Panama Canal with which General Abbot leads this issue, he does not favor the sea-level project; but the manifest fact will appear to them that the point is to be decided not by the sentiment or the *seeming* conditions embodied in a name, but by the *actual* conditions which would exist, and by the clear logic of fact. General Abbot's article is a brief and most succinct statement of these conditions as they are known to him, and the conclusion to which they lead. This conclusion, it is hardly necessary to repeat, is that the sea-level canal would not be the safest nor the most attractive to navigation, chiefly because the treatment of the problem of the Chagres which it necessitates is far from satisfactory. That which is embodied in the lock and summit-level plan, on the other hand, is absolutely complete and transforms the river from a menace into an aid. And it must be kept plainly in view, in studying the question, that in the navigation of narrow waterways, deep-sea navigators attach vastly more importance to maximum safety than to minimum time.

In construction also, as well as in operation and maintenance, the lurking menace of the unforeseeable and unpreventable seems to hang about the sea-level scheme. This is clearly suggested by Mr. Grunsky in his comment upon the increased difficulties of the Culebra cut if carried to the vast dimensions demanded by a sea-level canal. It is touched upon also by General Abbot in his reference to the river-diversion tunnel which forms part of the scheme, and the point seems worthy of strong emphasis. A tunnel of the length and cross section demanded by the conditions of this case would be a serious proposition even in the most favorable formation—and the formation on the Isthmus is distinctly the contrary of favorable. It is folded, faulted, shattered—eruptive, and even now not wholly free from earthquake disturbance. In a sense, any engineering undertaking is possible; but concerning the proposal to bore such a hole as this through such materials as are likely to be encountered, one might well quote the dictum of a high authority concerning the discarded ship tunnel of another route—that "the possible contingencies of an undertaking of this kind might well prove such as to tax the abilities of the most able commission, backed by a rich and generous Government."

* * *

WHILE we sincerely respect the Commission's determination to consider every type of canal, from the sea-level to the highest summit proposed, we are inclined to attach more weight and finality to the conclusions of preceding commissions than is intimated in Mr. Grunsky's paper. The late Mr. George S. Morison expressed to us the most confident conviction that the studies of the commission of which he was a member were ample to decide not only the relative merits of the Panama project, but the absolute type of canal to be built. It is well known that his judgment approved a summit level at a normal elevation of 85 feet, making a single large lake, extending through the Culebra cut and thus greatly reducing the necessary excavation there. As he put it in a conversation very shortly before his death: "Your two big problems are the Culebra cut and the regulation of the Chagres. They must be treated together. By raising the crest of the Bohio dam, you reduce by so much your maximum cut, and at the same time make the summit lake high enough and large enough to receive and control the floods of the river. The one problem disappears and the other is minimized." General Abbot, whose familiarity with the hydraulic data of the problem is unrivalled, most earnestly advocates a summit level of only 66 feet, with a second dam above this at Alhajuela, to control and regulate the volume admitted to "Lake Bohio," urging that this plan presents important advantages in construction and secures more absolute certainty of the maintenance of water supply and of unembarrassed navigation under all possible conditions. We believe that the present Commission might justifiably, and even commendably, have limited its consideration to these two main plans and certain variants.

* * *

Mr. Haskell's article on American railway accidents, which appeared in our issue for December has attracted widespread notice, which reaches us mingled with an outcry from those who feel themselves arraigned, and from their would-be apologists. Perhaps the most remarkable comment is that made by the New York *Tribune*. If engineers are not allowed to disregard signals, it says, the trains will be delayed. To come down to the level of this "criticism," we may point out that when signals *are* disregarded, the trains are, not infrequently, still more seriously "delayed." There is, however, in all well informed quarters a very general recognition of the correctness of Mr. Haskell's analysis, and in many a distinctly apparent relief that someone has been found with the independence and the courage to speak plainly. Even the railway periodicals, while protesting against the admission that anyone who is not an active railroad official could possibly have any useful ideas on railroad affairs, yet reluctantly grant that there is "something" in these views.

Next to that of the *Tribune*, the widest miss in getting at the point is made by some of the labor organs, which grow very angry and vituperative at the supposed disposition to throw all the blame on the employee. It should be clear enough to anyone capable of reading and understanding good English that the conditions charged by Mr. Haskell point most accusingly to "the man higher up." By practically punishing strict obedience to rules when it entails delay in train movement, and by ignoring disobedience to the same rules so long as no actual accident follows, the "man higher up" forces the engineman to take the chances which too often result in disaster—and then retires behind the screen of the rules he made to be broken, and leaves the unfortunate employee to bear the responsibility of having broken them. It is he, and not Mr. Haskell, who puts the blame upon the engine and train crews.

* * *

We have received from the secretary of the American Society for Testing Materials a communication explaining the present methods of conducting the work of the organization, from which we make some interesting abstracts.

The International Association for Testing Materials, with which the American society is affiliated, has for its objects: "the development and unification of standard methods of testing; the investigation of the technically important properties of the materials of construction and other materials of technical importance, and also the perfecting of apparatus used for this purpose."

At the last congress of the International Association, held in 1901, at Budapest, the following resolutions were introduced, and adopted:

I. On "the creation of an International Committee on the testing of cast iron and the establishment of standard methods of testing and specifications." Referred to the council for more careful consideration.

II. "Committee 1 is directed to submit to the next congress a report on the possibility of establishing standard international specifications for the quality of materials, basing its investigations on its tabulation of specifications in the various countries, and in case the report be favorable, to present a definite proposition with reference to the same."

III. "In case this motion be approved by the congress, it shall be extended to cement, and that part of the work be assigned to Committee 2."

At the tenth meeting of the council, held in Vienna, March 1–2, 1902, the following action was taken on Resolution I, above:

"That the question of uniform methods of testing be separated from that of uniform specifications for delivery; that the first part be assigned to a new committee and the second to Committee 1."

In the judgment of the executive committee of the American society, the subjects of specifications and methods of testing are indissolubly connected, except in so far as testing for strictly scientific purposes is concerned. Interest in the latter field being confined to a comparatively limited number of individuals in this country, a beginning was naturally made with such work as appealed to a wide circle of American engineers and to the consumers and manufacturers of the materials of construction. Care was taken, however, not to allow subjects of commercial interest to overshadow those more strictly scientific.

It thus appears that the American society has decided to consider the questions included in methods of testing in connection with the specifications for the materials under consideration, and in the specifications already prepared directions for testing are found. The American society has also appointed special committees on the following subjects:

1. Standard Methods of Testing.
2. Uniform Speed in Commercial Testing.
3. On Standard Tests for Sewer Pipe.
4. On Standard Tests for Lubricants.
5. On Reinforced Concrete.

Under these circumstances we may expect reports upon the subjects referred to these committees and we shall await their appearance with interest. We understand that the first of these committees is expected to make an early report on the standard forms of test pieces adopted by the British Engineering Standards Committee, while the committee on reinforced concrete is co-operating with like committees of other leading societies, and a joint committee on this subject is now actively at work.

* * *

If the amount of matter, written, printed, and spoken, about the steam turbine were to be taken as a measure of its preponderance in the department of prime movers, it might also be assumed that the days of the reciprocating steam engine were already past, and that the machine which was our main reliance yesterday had today become a candidate for the halls of the engineering museum. Nevertheless the many and great establishments which are devoted to the design and construction of reciprocating engines continue to manufacture their products, while the comparatively limited number of shops devoted to the construction of steam turbines is not being very rapidly enlarged. The steam turbine is all right, and the claims which are made for it by its most enthusiastic advocates are based upon sound mechanical and technical principles, but the industry of manufacturing steam engines need by no means be stampeded on that account.

Apart from the direct considerations which may be advanced in favor of the turbine over the piston engine, there are several points to be taken into account—points which, while now secondary, may ultimately become of controlling importance in connection with the impending transformation in the design and use of motive-power machines. As has been well shown by Professor Denton, in his thoughtful paper presented before the International Congress of Arts and Sciences, the reciprocating steam engine appears to have reached very nearly the practical limit of steam economy which may be expected from that type of construction, so that the turbine must begin where the reciprocating engine leaves off. It is not expected, however, that the steam turbine will greatly surpass the piston engine in steam economy, and its greatest advantages appear in its freedom from the inertia effects of reciprocating motion, and in its direct application to electric generators, screw propellers, centrifugal pumps, and similar machinery.

As a matter of fact it appears as if the turbine had arrived just in time to form a sort of intermediate machine between the reciprocating steam engine and the improved internal-combustion engine, and that while many steam turbines will doubtless be constructed and used, the reciprocating piston engine will be found working along by its side until both are outstripped by the machine which uses the direct products of combustion for the generation of motive power without the intervention of the vapor of water.

* * *

Among the rivals to the steam engine and the steam turbine, the gas turbine offers most enticing attractions, and the eagerness with which any authentic information concerning actual experiments in this line is sought is evidence of the extent to which the subject is being studied. Theoretically the gas turbine should be an operative machine from which an efficiency nearly, if not quite, equal to that of the four-cycle reciprocating internal-combustion motor may be obtained. Practically there are many difficulties in the way, difficulties which it may require the utmost ingenuity of designer and constructor to overcome.

Thus the conditions of maximum efficiency in such a machine involve rotative speeds at which the centrifugal stresses become greater than the resistance of any available material of construction, while at the same time the working temperatures are indicated to be those at which the resistance of almost any material would be gone anyhow. The efficiency of the gas turbine itself becomes also involved with that of the efficiency of some appropriate form of air compressor, and the rotary air compressor available for such purpose involves nearly if not quite as many constructive difficulties as those of the gas turbine itself. Nevertheless we believe that the gas turbine will ultimately be made, and that it, or something like it, will be found superior to any steam engine which can be constructed. Meantime, the builders of reciprocating engines and of steam turbines will continue to produce their respective machines without fear of losing their business over night, and the advent of the gas turbine will be heralded sufficiently far in advance to permit them to give themselves ample protection.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

HYDRAULIC POWER IN GREAT BRITAIN.

THE POSSIBILITIES OF COMPETITION OF HYDRAULIC STATIONS WITH STEAM POWER IN THE UNITED KINGDOM.

E. Ristori—Engineering.

DURING the past ten or fifteen years there has been a great activity in the development of hydraulic power, this being doubtless stimulated by the opportunity of electrical transmission and application. In this development Italy has under utilisation about 300,000 horse power, and France 500,000 horse power, while in Great Britain it is estimated that there is not more than 10,000 horse power of hydraulic energy now developed. In a paper in a recent issue of *Engineering*, Mr. E. Ristori discusses the possibility of the development of a much greater quantity of water power in the United Kingdom, and shows that it may be able to compete very effectively with steam power.

The meager development of British water power Mr. Ristori attributes to two causes: the natural reluctance of the people to take up with new things, and the prevailing idea that there exists no water power capable of successful development, especially in competition with steam in a land where coal is cheap.

"The most natural sources of water-power are waterfalls, such as the falls of the Rhine, those of Shawinigan, Niagara, and many others. But these are by no means the only instances where water-power may be developed, as wherever there is a combination of a large watershed near to such geographical formation of the ground affording a suitable site for a reservoir, and a considerable difference of level within a short distance of the storage, water-power may be developed advantageously. On the West Coast of Scotland, in Wales, and in the West of Ireland there are a great many places where these conditions can be found, and where water-power can be developed just as cheaply as in many places abroad.

"The climatic conditions in these districts are very favorable to water-power, as, first of all, the rainfall is much larger and more uniform than in most places. This means that the watershed required for a certain amount of power is smaller in proportion, and also that the capacity of the reservoir need not be so large. For instance, it is quite safe to provide storage for only 100 days in these places, whereas in other countries it would be necessary to provide for 150 or even 200 days to avoid any risks in case of long droughts.

"Another advantage in favor of these districts is the uniformity of the climate, as either great heat or intense cold are seldom experienced. The difference between the maximum and minimum yearly temperatures is comparatively small, which facilitates greatly the construction of pipes and transmission lines. as the expansion and contraction of the metals is limited. The winters are also much milder, especially in the West, and, therefore, there is no danger to be feared on account of hard frost.

"Another great advantage is that in the west of the British Isles there is not likely to be lack of water during the winter months, which is generally the case in such countries as Switzerland, north of Italy or Canada. in fact, in all countries where snow is depended on for storage, and where, owing to the very cold weather in winter, the snow is held up and the rivers run nearly dry."

It being seen that the geographical and climatic conditions are as favourable in Great Britain as in other countries, but it remains to be shown that hydraulic power can compete with steam, under existing conditions. In general the opinion is that the cheapness of coal in the United Kingdom, and the efficiency of modern engines, permits little, if any, advantage in the use of water power.

"This statement is based upon the misapprehension that coal is the largest item in the cost of power produced by steam or gas. This is true in such localities where coal reaches very high prices, owing to distances from the coal-fields and difficulties of transport. Generally, however, this is not the case, and, in fact, the cost of fuel is only one of the many items, and proportionately not a large one, that go to make up the total actual cost of generating electric energy.

"It must be borne in mind that, in order to work a steam plant to the best advantage, a number of auxiliary appliances are required, such as coal-handling plant, mechanical sotkers, economisers, condensing plant, besides the necessary feeding-pumps, and other machinery. All these items involve a large capital expenditure, with the resulting heavy maintenance and depreciation. Also, it is well to remember that a steam-power factory involves much ground and a large building to house engines, boilers, and all other appliances, and also necessitates chimneys, and other structures.

"In the case of water-power installations the station buildings are much smaller, as only space for turbines is required. The electric portion of the plant, and the space taken by it, must be exactly the same whatever may be the source of power; therefore a water-power generating station must be smaller and less expensive than one where steam is the motive power.

"As regards the capital cost of the installations, in either case it is interesting to compare the figures, analysing at the same time the methods by which the expenditure is incurred. The electrical portion of the plant in any generating station is independent of the motive power used, whether steam or water, but has to be designed suitable for the purpose for which the station is required."

Mr. Ristori computes the capital and operative costs of hydraulic power plants with those operated by steam, under the conditions existing in Great Britain and shows that the installation costs of a water-power plant should not exceed £20 per horse power, and that in many places this may be reduced to £10 to £15 per horse power. The permanent character of the works renders it safe to estimate the depreciation charges at not more than 1 per cent. per annum, while interest is taken at 5 per cent. on the investment. In the case of steam power, the installation costs range from £15 to £20 per horse power, while the nature of the plant requires a depreciation charge of not less than 5 per cent. per year, the capital again bearing 5 per cent. interest. Under these conditions the fixed annual charges work out 12s. to 24s. for the water power, as against 30s. to 40s. for steam, the running expenses to be added in both cases. Mr. Ristori considers a number of cases at different load factors, and comes to the conclusion that the annual cost of a steam horse power in Great Britain will be, in round numbers about £4, while water power under similar conditions will not exceed £2 per horse power per year.

It is undoubtedly true that the public opinion about water power is influenced by the conspicuous examples of great power stations at the well known waterfalls which have been provided by Nature, but it is also true, as Mr. Ristori states, that large amounts of hydraulic power may be obtained under less imposing conditions. In the United States some of the largest hydro-electric stations have been developed from sources at one time inconspicuous. Thus the water power at Massena, in New York, has been developed simply by cutting a canal across from the St. Lawrence river to the Grasse river, utilising the difference in level between the two streams at a point where they are but a few miles apart. In the Western States it is a common plan to obtain water power by diverting a portion of a stream and carrying the flow along in a ditch with but a small slope until the fall in the main stream has given sufficient difference in level to provide for the necessary power.

There is no doubt that similar methods would enable much valuable water power to be developed in Great Britain with but moderate installation cost where at present nothing is apparent.

The influence of the cost of fuel upon the cost of steam power is also a matter concerning which there is often a misconception. As a matter of fact the fuel element in the cost of steam power is but one of a number of items in the steam-power cost account, and in the United States, with coal costing from $3.00 to $5.00 per ton, it has been found that in a large power plant the fuel cost ranges from 40 to 50 per cent. of the total, and any variation in fuel consumption therefore affects the result in about those proportions.

THE DEVELOPMENT OF THE ELECTRIC LOCOMOTIVE.

A COMPARISON BETWEEN THE STEAM AND THE ELECTRIC LOCOMOTIVE FOR MAIN-LINE RAILWAY SERVICE.

Howard S. Knowlton—American ***Electrician.***

WE have referred already in these columns to the highly successful trials which have been made with the first of the powerful electric locomotives for the New York Central Railroad, and now we have a paper in the *American Electrician* by Mr. Howard S. Knowlton discussing the influence which the development of these machines may have upon rapid transit on main and local railways.

The electric locomotive is by no means new, but its work has until recently been limited to special service in localities where steam machinery is objectionable. In the United States the principal application has been in the Belt Line Tunnel at Baltimore, and in Europe the operation of the extension of the Orleans Railway in Paris, discussed elsewhere in this issue, forms the most notable example. A few years ago a fatal and most costly collision in the Park Avenue tunnel in New York City called attention to the danger of the continuance of steam locomotives for this service, and the result has been the most powerful impetus which has yet been given to the question of electric traction on main lines.

The new locomotives for the New York Central Railroad have already been described in these columns, but Mr. Knowlton makes some interesting comparisons between them and steam locomotives in general and with a typical locomotive in certain details.

"Small resemblance exists between these electric locomotives and their steam prototypes. The frame is of cast steel; the wheels and trucks are of substantial design also; but the absence of the usual enormous boiler, cylinders, connecting rods, stack and tender results in an affair which looks more like an iron box mounted on wheels than anything else. The cab is built in the middle of the locomotive, and the machine will run equally well forward or backward without turning around. Of course, the steam locomotive will do the same thing, but the electrical horse has no front and rear ends, each end being front or rear according to the direction which happens to be taken. Practically none of the mechanism is visible—a marked contrast to the old-time locomotive. The new machines are equipped with electrically driven air compressors for operating the brakes and whistles, a bell and sanding device, and an electric headlight at each end. The cabs will be heated by electricity, and the motive power is furnished by four 550-h. p. motors capable of being overworked up to a total of 2800 horse-power. This means that each machine is half as large again as the largest steam passenger locomotive in existence, as far as power is concerned. They are designed to pull light trains at speeds as high as 75 miles per hour, and when it is desired to make fast time with the heaviest limited Pullman trains, two electric locomotives can easily be coupled together and operated by a single driver. This is made possible by the multiple unit control system, which is very similar to that used on the Boston and Manhattan elevated trains.

"It is interesting to compare the electric machines with a typical suburban steam passenger locomotive, such as is used by the Philadelphia & Reading Railroad. The electric locomotive weighs 95 tons, against the steam's 100; the length of track occupied by its wheels is but 27 feet, against its rival's 30 feet 9 inches; its driving wheels are but 44 inches in diameter, against the Reading engine's 61⅝ inches, while the steam machine has a 'tractive effort' or horizontal pulling force of but 18,000 pounds, compared with 22,800 pounds in the electric locomotive. Even the latter can be considerably exceeded for short intervals without injuring the motors. Comparing the New York Central machine with one of the largest passenger locomotives in the world—the 175-ton engine of the Santa Fé system—the steam machine requires 62 feet 10½ inches of track to accommodate its wheels, or more than double the length taken up by the electric locomotive, while with a weight of 74 tons upon its 69-inch driving wheels it can develop but 22,200 pounds horizontal pull. In other words, the Reading engine, especially designed for rapid acceleration, has a pulling force of but 180 pounds for each ton of its weight; the Santa Fé machine has 127 pounds tractive effort per ton of its bulk; while the New York Central outfit will easily show 240 pounds tractive force per ton of its weight. A great advantage of the electric locomotive in this connection is the uniform pull exerted throughout each revolution of each driving wheel, made possible by the rotary motion of the motors, as contrasted with the reciprocating mechanism course, that the electric trains can attain of the steam engine. This means, of full speed in a much shorter time than trains propelled by steam."

As we have already noted, the introduction of electric traction on main lines has not been welcomed by railway engineers and managers. On the contrary, it has been forced upon them by reason of the external pressure to abate nuisances or prevent disasters. Its general use cannot be expected until it has been demonstrated that there is a material commercial advantage, and that electricity, plus stationary power houses, is cheaper than the traveling power houses we call locomotives. Apart from the question of actual cheapness there may also be considered the approach of the heaviest modern freight locomotives to the limit of operative capacity. It has already been realized that the firing of the modern heavy merchandise engine is becoming too severe a task for one fireman. The use of two firemen has been found unsatisfactory, and the perfect mechanical stoker for the locomotive has not yet been produced. Still the demand comes for greater boiler power, involving greater coal burning capacity, and it may be that the close approach to the limit of capacity in this direction may compel the removal of the power house from the wheels and cause it to be placed where its size does not affect the operation. Still it must not be understood that all difficulties will be removed by the removal of the motive power from the traveling machine. Some evils will disappear, but others will take their places.

"One must not imagine that the elimination of many of the inconveniences of steam locomotion means that the adoption of electric motive power has no drawbacks. Breakdowns in equipment cannot always be prevented, even with motive power designed for continuous service, and the light of much experience is needed before the conservatism of the steam railway world can be convinced that electricity can be commercially applied to trunk line operation. We may escape leaky boilers, poor coal and low steam only to find ourselves delayed by short-circuits, blown fuses, armature burn-outs, poor contacts, and other sources of failure; the snapping of overhead wires, and accidents to which powerhouse engines are liable—all are fraught with power to incur great inconvenience. The very concentration of the power supply in a few large prime movers makes any delay or accident all the more serious. The bursting of a single steam pipe may tie up a whole division—something most improbable with present methods of operating railways, where each engine carries its own power station upon its trucks. It is not easy to exaggerate the loss in time and money which would result from even an hour's blocking of the suburban traffic of a great railroad system like the New York Central through the failure of some small but important link in the chain of energy transformations which connects the power-house coal pile with the wheels of the electric locomotives. At the best, the adoption of electric motive power means increased complication of equipment in power-house, line and substation, or distributing point, construction. There are many unsettled operating and maintenance problems which only experience can solve. The handling of suburban traffic of a city like New York or Boston, complicated as it is with transcontinental through travel, is a very different proposition from operating either street or elevated cars and trains."

So far as the matter of speed is concerned, the limitations in that direction are not altogether mechanical. The experiments upon the Marienfelde-Zossen military railway have demonstrated that under exceptionally favorable conditions an electric locomotive can make a speed which for a short time corresponds to a rate of 131 miles an hour, but that it is a very different thing from maintaining such speeds over long distances in regular service. It is now well understood that the limit of physical and nervous endurance is closely reached on steam locomotives with line speeds of 60 to 75 miles an hour, so that in this direction either type of motive power is well capable of meeting the practical requirements.

There is every reason to believe that electric traction on main-line railways will soon be given ample opportunity to show what it can do, and the result will doubtless be a process of evolution in the course of which the fittest will survive.

SPECIAL NICKEL-STEEL ALLOYS.

RECENT APPLICATIONS OF THE NICKEL-STEEL ALLOY OF MINIMUM EXPANSION IN GEODESY AND HOROLOGY.

Comptes Rendus—Nature.

WE have repeatedly referred in these columns to the interesting results which have been obtained with various alloys of nickel and iron, and more than three years ago a leading article was published in this magazine, by Professor Guillaume, to whom most of the information is due concerning the subject. We now have an account of the latest results in this important and interesting field of research in a paper by Professor Guillaume published in *Nature,* as well as a contribution by M. Mascart in a recent issue of *Comptes Rendus,* from both of which some abstracts are made.

The effect of the addition of a small percentage of nickel to steel in increasing the toughness of the product has been known and used by manufacturers for many years, but it was not until the scientific researches of M. Guillaume that the curious properties of the higher alloys were developed. These investigations of M. Guillaume were stimulated by certain observations concerning the physical properties of certain nickel-steel alloys, notably the fact noted by Dr. John Hopkinson, in 1889, that a ferro-nickel containing about 25 per cent. of nickel had its density reduced by about 2 per cent. after cooling to the temperature of solid carbon dioxide, and also the observations of M. Benoit, in 1895, upon an alloy of iron with 22 per cent. of nickel and 2 per cent. of cromium, this having a coefficient of expansion half as great again as that required by the law of mixtures.

The most apparent peculiarity of certain nickel-steel alloys was the fact that, although composed of two magnetic elements, some of them were not themselves magnetic except under certain conditions, and further investigation showed a relation between the properties of magnetism and expansion. These relations have been discussed at length by M. Guillaume, both in the article written by him in this Magazine in 1901, and in a more recent paper in the *Revue Générale des Sciences,* and his present paper deals more directly with the practical application of certain of the alloys, notably that containing 36 per cent. of nickel and 64 per cent. of iron, this being the alloy of minimum expansion. Because of its practical invariability in length under ordinary differences of temperature, this important alloy has been given the name of "invar" by Professor Thury, and under that name it is now generally known.

According to the diagram given by Professor Guillaume, the coefficient of expansion of invar is about 1 micron per metre per degree centigrade, or about one part in one million, but a slight variation in the proportion of either element causes a rapid increase in the value of the coefficient, so that the greatest care is required in the manufacture of the alloy. Thus, the 27 per cent. alloy has about the same coefficient of expansion as iron, while a nearly proportionate rise occurs if the percentage is increased beyond the 36 per cent. nickel content. When the material is required for particular purposes, price being a secondary consideration, it has been found possible to select samples which have a zero or even a negative expansion, the alloy in the latter case actually becoming shorter for an increase in temperature.

These properties naturally indicated the adaptability of the alloy for the manufacture of standards of length, the troublesome temperature correction being eliminated. Careful experiments, conducted over considerable periods of time, have shown, however, that there is a slow, and very slight increase in length with the lapse of time, this increase being about 1/100 of a millimetre in five or six years, at ordinary temperatures, after which the subsequent yearly lengthening does not exceed a fraction of a micron. This action may be enormously accelerated by heating, so that bars may be seasoned in this manner, and their error from this cause almost entirely eliminated, but this fact renders the alloy unsuitable for use in the production of reference standards of the first order.

For working geodetic standards of length, however, invar has shown itself to be admirably adapted, especially in connection with the Jäderin system of base-line measurement with wires operated under constant tension. The old method of base-line measurement, using bars of moderate length, is slow and cumbrous, while the frequent repetition of readings multiplies in corresponding degree the element of observation errors. Unless the iced bar is employed, the temperature correction becomes an important matter, including all the difficulties of determining the true temperature of the bar, so that the operation is one demanding improvement. The original apparatus of Jäderin involved the use of two wires, one of steel and the other of brass, these being of the length of the standard tapes, usually 24 metres, or sometimes 100 feet, the ends being provided with short graduated scales. The wire, when used in measurement, is supported upon tripods at the ends, and strained taut by a constant weight, and it is possible by its use to measure a base fully 10 times as rapidly as with the bars formerly employed. By making the measurement simultaneously with wires of brass and steel the difference could be used as a measure of the mean temperature, from which the proper correction of the length given by the steel wire might be deduced. The application of wires made of invar to this method will readily appear, and trials were so encouraging that it was decided to use a single wire of the nickel-steel alloy for the base measurements in the Spitzbergen survey. An account of this work has already been given in these pages, and it has been shown by comparative measurements of the same base that the error was only 1/500,000, without any temperature correction whatever. Similar experiments in connection with the French equatorial survey in Ecuador have shown that the difference in the measurement of a base with a bimetallic scale and with a wire of invar was 1/3,300,00.

In order further to establish confidence in the reliability of wires of invar for geodetic measurements, a number of experiments have been made by MM. Benoît and Guillaume at the Bureau of Weights and Measures, more than a hundred thousand comparisons having been made during the past four years. In general, it may be stated that the introduction of this method of measurement has enabled base lines to be measured with an accuracy well within the limit of accuracy of the angular measurements, so that the general reliability of a survey may be controlled by the frequent and convenient measurement of base lines.

The communication of M. Mascart to the French Academy relates to the use of invar as a material for the pendulum of an astronomical clock. By the employment of the method of Lippmann of maintaining the impulses by electro-magnets it was found possible to use simple pendulums, without any compensation, in operation in closed cases under constant pressure, with a variation of 2 seconds in 24 hours. The experiments showed that the opportunity for error was greater in the mode of suspension than in the effect of temperature changes, the use of invar rendering the gridiron or mercurial compensation unnecessary. The low cost of such pendulums renders them especially applicable for railway service and similar operative work.

Professor Guillaume also calls attention to the application of other nickel steels in horology. Thus the 24 per cent. alloy has the property of changing its modulus of elasticity with an increase in temperature, and this variation may be employed to compensate for the change in the elasticity of the spring of a watch at different temperatures. The use of a nickel-steel alloy in connection with the construction of the compensating balance of a chronometer has also resulted in a material improvement in the rate, this enabling the so-called Dent's error to be almost entirely eliminated. The ability to vary the coefficient of expansion by changing the composition of the alloy has rendered it possible to produce certain special metals of peculiar value. Thus, it has been found necessary to employ platinum wire for all electrical connections which involve the fusion of a wire into glass, because the expansion of platinum is practically equal to that of glass, and there is thus no tendency to crack the glass with any change of temperature. Attempts to use wires of other materials have been unsuccessful, since the glass always cracks around the wire. By using an alloy containing 45 per cent. of nickel, a coefficient of expansion identical with that of glass is obtained, and this material, to which the name platinite has been given, is already extensively used in connection with the manufacture of incandescent electric lamps.

In concluding his paper, M. Guillaume calls attention to two interesting features.

"All these applications which to-day give new resources to science and new economies, representing large sums, to industry, arise from a peculiar phenomenon of equilibrium in the mutual solution of two isomorphous metals; that is one interesting side of the question. There is another one on which I would insist in concluding; it is that these results have been obtained as a sequel to a long series of delicate measurements in which the thousandth of a millimetre was the ordinary unit, and without which no discovery in this domain would have been possible."

MAGNETIC FLUX DIAGRAMS.

INVESTIGATIONS INTO THE ANALOGIES BETWEEN HYDRODYNAMIC PHENOMENA AND MAGNETIC-FLUX DISTRIBUTION.

Institution of Electrical Engineers.

SOME of the difficulties which have been experienced by students and engineers in dealing with problems in electricity and magnetism have arisen from the uncertainty in the formation of correct mental conceptions of what actually takes place in connection with the distribution and behaviour of the invisible forces under consideration. For this reason it has been attempted more than once to derive mechanical or other concrete or visible analogies which might render clear the relations ordinarily expressible only by means of mathematical formulas. Thus, the very term electric current has grown out of the early idea that electricity was in some way analogous to a fluid, and that its passage along a wire might be conceived as something like the flow of a current of water through a pipe. In like manner the term pressure is used as equivalent to voltage, from the analogy between electrical pressure and the pressure of an elastic fluid under confinement. Such analogies must necessarily be used with caution, since there is no absolute warrant that they are complete, and occasional evidences show that they are not, but when checked by comparison with the theoretical treatment of the subject, and employed always with the clear understanding that they are only analogies, they may prove valuable auxiliaries in study and demonstration.

Recently some very interesting experiments have been made to represent, by hydrodynamic action, the phenomena which occur in the distribution of magnetic flux, with especial reference to the armatures of dynamos. The results of these experiments have been embodied in a paper presented before the Institution of Electrical Engineers by Professor H. S. Hele-Shaw, Dr. Alfred Hay, and Mr. P. H. Powell. The nature of the paper is such that it requires for its complete presentation some reproductions of the interesting photographs, together with portions of the mathematical demonstration, but some abstract of the general method may be given here, together with the conclusions.

"The laws which govern the distribution of magnetic flux in space of two dimensions are identical with those which apply to the stream-line motion of a perfect incompressible fluid in two-dimensional space. If, therefore, we had such a fluid at our disposal, and by causing it to flow between parallel biunding walls determined the distribution of the stream-lines, this distribution would also represent that of the magnetic lines or tubes in a corresponding two-dimensional magnetic problem. This is the underlying principle of the hydrodynamical method as applied to magnetic problems. In trying to put the principle of this method into practice, we encounter the following difficulties:

"(1) The difficulty of mapping out the invisible stream-lines of the fluid. (2) The fact that there is no such thing as a 'perfect' fluid at our disposal, every actual fluid being more or less viscous. (3) The difficulty of finding an analogue for magnetic permeability, in order to enable us to study the flux distribution in cases where the field consists of regions having different permeabilities.

"The first difficulty is surmounted by using a colourless liquid into which are injected thin colour-bands, consisting of the same liquid mixed with a suitable dye.

"The second difficulty at first sight appears insurmountable. But a closer mathematical investigation by the late Sir G. G. Stokes has revealed the somewhat astonishing fact that when any viscous liquid is made to flow in a very thin layer between parallel bounding walls, *the stream-lines obtained are identical with those of a perfect liquid.*

"The third difficulty consists in devising a method by means of which the effects of varying magnetic permeability may be imitated. Now it may be shown, both theoretically and experimentally, that when a viscous liquid flows in a thin parallel layer, the quantity of liquid passing per second across a plane of unit length drawn normally to the stream-line is, for a given pressure gradient inversely proportional to the cube of the thickness of the liquid layer. Hence, if the liquid is made to flow through several regions of different thickness, the ratio of the cubes of the thicknesses gives the ratio of the permeabilities in the corresponding magnetic problem.

"The practical method employed by us consisted in coating one of the thick glass plates forming the slide with a thin layer of paraffin wax, and then forming a cavity or cavities of the required shape by carefully scraping away the wax over certain areas. These areas, over which the liquid layer had a greater thickness, represented the regions of high permeability. The permeability varying in proportion to the *cube* of the thickness of the liquid layer, no difficulty was experienced in constructing slides in which the permeability over certain regions had as high a value as 1,000. The slide through which the liquid flowed being suitably illuminated, a photograph of it was taken, and thus a permanent record obtained of the particular stream-line distribution. The stream-line diagrams which accompany the present paper are reproductions of the photographs so obtained. The validity of the hydrodynamical method having been established, we proceeded to apply it to some problems in dynamo design whose solution has always been a matter of considerable difficulty. In order to render the investigation more complete, however, we decided to supplement the results obtained by the hydrodynamical method by experiments carried out on an actual dynamo fitted with several armature cores having different sizes of teeth and slots, and different air-gaps. In the calculation of the magnetomotive force required to produce a given magnetic flux in a dynamo having a toothed-core armature, the designer encounters two important difficulties. The first of these is the determination of the reluctance of the air-gap, including the allowance to be made for the distortion due to the armature teeth and for the fringing effect around the edges of the pole pieces; and the second is the determination of the reluctance of the teeth themselves. It is in connection with the first problem—that of air-gap reluctance—that the hydrodynamical method is of particular value."

It is evident that the distribution of magnetism is not the same in the case of a toothed armature as it would be for one with a smooth core. The teeth, however, are required for constructive purposes, and it is therefore important to be able to determine the extent to the disturbing influence due to the departure from the cylindrical form, and to make the corresponding correction before proceeding with the computations. The beautiful stream-line diagrams given in the paper, and projected upon the screen at its original presentation, show very clearly the deviation caused by the presence of the teeth, and the distribution of the lines enables the proper correction to be made.

"It is at once obvious, without the necessity of going into any elaborate investigation, that the presence of teeth in the armature core is equivalent to an increase in the gap length (or a reduction in the gap area); for the teeth disturb the uniformity of the flux distribution, causing a crowding of the lines into the regions of the polar surface which are opposite the teeth, and thereby increasing the fall of magnetic potential, from the polar surface to the crown of any tooth, above the value which it would have if the distribution were uniform (*i.e.*, if the core were smooth) and the total flux unaltered. Assuming that the exact effect produced by the teeth is known, a convenient method of applying the necessary correction consists in multiplying the gap length by a certain 'correction coefficient,' and then, using this corrected value, in proceeding with the calculation as if the armature core were smooth—*i.e.*, as if the flux distribution were uniform. The 'correction coefficient' clearly represents the ratio of the maximum to the mean induction.

"The value of this correction coefficient depends on the ratio of the width of slot to the top width of the tooth and to the length of the gap, and by a comparison of stream-line diagrams corresponding to various values of the two ratios a very good idea of the effect produced by the various kinds of teeth may be formed.

"The chief value of the diagrams, however, lies in the fact that they enable us to determine the numerical values of the correction coefficient in the various cases. All that is necessary for this purpose is to determine the number of stream-lines per unit of length in the space well under cover of a tooth, and to divide this by the mean number of stream-lines per unit of length for tooth and slot. Attention may be drawn to one or two features clearly exhibited by the diagrams. Two well-known effects are shown very plainly: the *refraction* of the lines as they pass from a medium of low into one of high permeability, and the crowding of the lines along the sharp edge of the tooth. It will be further noticed that between the straight lines in the region immediately above the tooth and the curved lines entering the slot and passing into the flank of the tooth, and exhibiting a concavity towards the tooth, there are certain intermediate or transition lines which are characterised by a point of inflection, the upper part of the line being concave and its lower part convex towards the tooth; the convexity gradually decreases as we take lines further and further away from the tooth, and is ultimately replaced by a concavity along the entire length of the line."

A check upon the correctness of the conclusions drawn from the stream-flow diagrams is given by the comparison with the theoretical researches of Mr. F. W. Carter, the tabulated results of the two methods agreeing very closely, and confirming the reliability of the method.

The paper also contains an account of investigations upon the reluctance of teeth in a slotted armature, this work being done upon a specially designed dynamo constructed for the purpose.

"The dynamo was of the single-bobbin type, with pole-pieces bored out to a diameter of 5½ in., and into the space between them could be introduced any one out of a set of five experimental armature cores. The cores consisted of sheet-iron stampings threaded on the shaft, and maintained in position by a feather key. The flux was determined by means of search coils at the top, the middle, and the bottom of a tooth. In addition to the three coils surrounding the tooth, a fourth coil was used for the purpose of determining the total flux per tooth and slot, and the mean value of the gap induction. This coil was slung in the middle of the air gap.

"The reversal of flux was produced by a bodily rotation of the armature with its search-coils through 180°.

"In order to arrive at a correct estimate of the net cross-section of iron in the tooth, a large number of measurements was made of the thickness of the disks forming the different cores, and the number of disks in each core was carefully counted. The exact dimensions of the various exploring coils were also determined with great care."

The results of these investigations are tabulated in the paper, and also plotted in curves from which the effect upon teeth of different cross-section is shown.

"The ballistic measurements show clearly the steady increase in the magnetic flux as we proceed down the tooth—so long as the induction at the base of the tooth does not exceed about 20,000. Beyond this limit, another effect, not indicated by the stream-line diagrams (in which the permeability is constant), comes into play. The flux, after reaching a maximum value at a certain depth, begins to decrease, lines of induction leaving the flank of the tooth and crowding into the slot. This effect is very strongly marked for all the higher values of the gap induction.

"For the range of gap induction used, the curves connecting the total flux through the top and middle cross-sections of the tooth with the mean air-gap induction are almost straight lines through the origin. For the curves relating to the base of the tooth, the initial portion only is straight."

LOCAL ELECTRIC RAILWAY TRACTION.

THE USE OF ELECTRIC LOCOMOTIVES AND CARS IN THE TERMINAL AND SUBURBAN SERVICE OF THE ORLEANS RAILWAY.

Revue Générale des Chemins de Fer.

IT is becoming evident that the introduction of electric traction on main-line railways is not to be effected by any method of wholesale conversion, with all the upheaval and expenditure involved, and it is also apparent that the electric system is gradually making its way in a manner which will ultimately cause its extension to the greater part of railway operation. Already electricity has become supreme for local and tramway operation, and the development of interurban electric railways is a matter of recent record. For special purposes electric power is coming into use in various departments of standard railway operation, and it is to some of these that the extension of the system may be looked for.

One of the first applications of electric traction for main-line service is that of providing entrance into terminals in great cities where the smoke and gases of the steam locomotive has heretofore acted as a deterrent nuisance. All railroads desire to possess satisfactory passenger terminals as near the heart of the city as possible, and until the development of electric traction the public has been willing to put up with the accompanying inconveniences because no substitute could be found for the offensive steam locomotive. In cities where entrance was obliged to be made through tunnels, as in the cases of Baltimore, St. Louis, and New York, the advantages of electricity have been most apparent, and the use of electric locomotives in the Baltimore tunnel was the first practical application of the method for the hauling of standard main-line trains.

When it was decided to extend the line of the Orleans railway in Paris from the Pont d'Austerlitz to the new terminal on the Quai d'Orsay, through a tunnel running along the river bank, it was found necessary to use electric locomotives to haul the trains over the new portion of the line, and a full account of this important installation was given in the pages of this Magazine in April, 1899, by Prof. Boyer. More recently it has been determined by the New York Central and Hudson River Railroad to employ electric traction to bring its trains into the terminal in New York City, this action being doubtless accelerated by the dangers and accidents accompanying the use of steam locomotives in the tunnel. The entrance of the Pennsylvania Railroad into New York City by means of a tunnel under the Hudson river has been made possible only by the availability of electric power for the traction service, and there is little doubt that the first and strongest hold of electric traction upon general main-line service will come by reason of the requirements of terminal conditions in great cities. In a recent issue of the *Revue Générale des Chemins de Fer* the development of electric traction upon the Orleans railway, following as a direct result of the use of electricity for the new terminal, is discussed in a paper by M. F. Paul-Dubois, and the subject is of sufficient importance at the present time to demand notice and review.

Since the introduction of electric traction upon the branch of the Orleans railway connecting with the new station in Paris, in May, 1900, the service has been in continuous and satisfactory operation. The electric locomotives haul from 150 to 200 trains daily, these ranging in weight from 150 to 350 metric tons, at speeds of about 50 kilometres per hour. This speed, corresponding to about 31 miles per hour, is limited by the operating conditions and not by the power of the locomotives, these being readily capable of double the speed, or more than 60 miles an hour, upon the clear and open line. The trains are taken from the steam locomotives at the Austerlitz station, and hauled to the Orleans terminal in 6 minutes, the times required for the substitution of the electric for the steam locomotives being uniformly less than 3 minutes.

Under these circumstances the management of the Orleans railway when called upon to increase the local traffic facilities, turned to electricity as a reliable means of traction, and the result has been the adoption of electric traction for the entire local service between Paris and Juvisy, a distance of 19 kilometres, or about 12 miles. In considering the change from steam to electric traction an important feature appeared in the gain in time due to the readier acceleration obtainable with electricity. Thus, with a train of 250 tons weight, stopping at all stations, there appeared a gain of 15 per cent. in time over the service of the powerful four-cylinder compound locomotives, and 25 per cent. over the ordinary local engines, this being entirely due to the prompt acceleration and not to higher running speed. Since it was the delay due to the numerous stops between Paris and Juvisy which retarded the general service, this portion has been converted to electric traction, using independent tracks on either side of the express track, and the relief gained by this arrangement has permitted the main steam service to be operated with satisfactory freedom.

The electric operation of the line calls for little comment, being principally an extension of the service which has proved so satisfactory during the past five years. A three-phase current at 5,500 volts is generated at the station at Ivry, this being transformed and converted to a continuous current at 600 volts for use on the line. Two substations are used, one at the generating station, and one at kilometre 13.45, these giving a convenient division of the distance.

The rolling stock included in the new service is of two kinds. For a portion of the work the electric locomotive has been found desirable, and these machines are similar to those which have proved so satisfactory in connection with the service of the Gare d'Orleans on the Quai d'Orsay. There are also a number of motor cars in use, these containing a cabin for the motorman, and compartment for baggage, and a number of third-class places for passengers. Two of these motor cars are used with each train, one at each end, the passenger cars being placed between, and all the motors being under the control of one man, by means of the Sprague multiple-unit system.

The introduction of electric traction on the Orleans railway has furnished also a convenient supply of electrical energy for a number of departments besides the traction service. Thus all the passenger and merchandise stations of the company within a radius of six kilometres are lighted from the central station; the water supply is furnished by electric power, both for the stations and the locomotives, and the handling is done by electric cranes, capstans, conveyors, etc. All the turntables and transfer tables are operated electrically, and numerous machine tools in the local repair shops are electrically driven. Electric power is employed in the passenger stations both for elevators and lifts, and also for traveling platform conveyors for baggage, and the presence of a supply of electric current has led to its use wherever it can be conveniently applied.

The whole outcome of the original plan to use a few electric locomotives to haul the trains through the tunnel to the new terminal has been the development of a system of electric-power application which it would have been almost impossible to have introduced in any other way, but which it would now be impossible to displace in favor of any earlier system. It is in this way that electric traction on mail-line railways will come elsewhere; first, for services for which steam power cannot be used, then for local traffic, which demands expansion, then for gradual extensions, and last of all for the through-line express service, where the steam locomotive will doubtless make its last stand and for which it will probably continue to be employed for a comparatively long time.

LONG-DISTANCE POWER TRANSMISSION.

THE MAXIMUM DISTANCE TO WHICH POWER CAN BE ECONOMICALLY TRANSMITTED BY MEANS OF ELECTRICAL ENERGY.

Ralph D. Mershon—American Institute of Electrical Engineers.

PREDICTING is always an uncertain process, but it is often necessary to make a forecast in any line of work in which progress is to be expected, in order to enable the best method of work to be indicated. At the present time the development of long-distance electrical power transmission is the subject of careful study, and the papers presented at the St. Louis Electrical Congress, reviewed in these pages in November last, showed the interest which was there taken in the question. In a paper recently presented before the American Institute of Electrical Engineers, Mr. Ralph D. Mershon proposed to take up the question of the limitations of the electrical transmission of power, and while some of his conclusions may be open to question the value of the treatment is apparent.

"In endeavoring to make such a forecast, as will be here attempted, it should be borne in mind that each additional limitation consequent upon the assumptions necessary in order to obtain definite representative figures adds to the chance of the forecast proving erroneous. For instance, the first assumption which must be made is that in the future power will be transmitted in the same way as now. This may not hold. There may be devised some other and better way not involving the use of transmission lines. Such, however, does not appear probable. Other assumptions as to methods of construction being the same as, or smilar to, those at present in use may be eventually so modified by skill and experience as to change very materially any conclusions arrived at now. This is less improbable. Conditions, industrial and financial, may so change that the constants now assumed as fixing costs, interest, etc., will be materially modified. This is probable. Finally, it is certain that with the course of time the value of power will increase, and this will materially alter any figures at which we may now arrive. The present conditions of practice and possibility are sufficiently definite, however, to warrant a forecast with the expectation that it will be applicable, approximately, at least, for some considerable time to come. At any rate, the method of treatment of the subject adopted will, with suitable changes in the values of constants, apply so long as present methods of power transmission obtain, and makes possible a comprehensive view of the possibilities of long distance transmission."

In the case of most attempts to discuss the subject the limiting element has been assumed to be some constructive or operative feature, but Mr. Mershon takes a wider view of the question, and shows that the limitations will come through economic considerations, as indeed they come with most engineering operations.

"The elements which, in the broadest sense, limit the distance to which power can be economically transmitted, are two; the cost of power at the generating station, and the price which can be obtained for the delivered power. The difference between these two elements must cover the cost of transmission, the interest on the investment, and the profit. The cost of transmission comprises the loss of power in transmission, the cost of operating, and the cost of maintenance and repair. The value of the sum total of the interest which must be paid upon the investment, and the minimum profit which is considered satisfactory, will have much weight in determining the limiting distance of transmission. The less this sum is the farther power can be transmitted; a low interest rate and a low rate of dividend will, therefore, be conducive to long transmissions.

"Let us consider in a general way the manner in which the investment in a transmission plant and the annual charges and expenses in connection with the plant vary with different outputs, voltages, and distances of transmission. For a given voltage, drop, and distance of transmission, the cost of all the apparatus and equipment, except the line conductors, will increase more slowly than the output of the plant. That is, the greater the output of the plant the less the cost per kilowatt of all the equipment, except the line conductors. This will be true of the operating expenses also. Therefore, since the interest charges and the charges for depreciation and repair are dependent upon the investment, the greater the output of the plant the less will be the quantities going to make up the annual cost per kilowatt of transmitting power, except those depending upon the line conductors. Since the weight of the line conductors under the conditions assumed will vary directly as the amount of power transmitted, those elements of the annual cost per kilowatt depending upon the line conductors will be practically constant for all amounts of power transmitted and cannot be materially reduced by increasing the amount of power transmitted. With the same voltage, economic drop, and output, the elements of annual cost per kilowatt due to the line structure (pole line) and to its extent (patrolling, etc.), will increase directly at the distance. But, as outlined above, any increase of cost in line structure due to increase in distance can be offset by increase of output. On the other hand, the weight of the line conductors increases as the distance (for the same *economic* drop) and the elements of annual cost per kilowatt due to the weight of the line conductors will, therefore, increase as the distance, no matter what the output.

"It appears, therefore, that all the elements in the annual cost per kilowatt for transmitting power, except those dependent upon the line conductors, may be continually reduced by increasing the amount of power to be transmitted. The annual cost per kilowatt due to the line conductors cannot be so reduced. It can be diminished only by such other means as will reduce the first cost of the conductors. As the first cost of the line conductors can be reduced only by increasing the voltage of transmission and as there is a limit to which such increase can be carried, it follows that *the limiting distance to which power can be economically transmitted will depend, finally, upon the cost of the line conductors and upon this alone.*"

In order to determine what this limiting distance is Mr. Mershon makes certain assumptions, and while some of these are beyond the values of current practice they are by no means inadmissable. So far as the much discussed matter of voltage is concerned, he shows that this is not limited by physical considerations, such as difficulties of construction, air losses between conductors, insulation, and the like. Rather is it an economic matter, for it can readily be imagined that the voltage can be carried to such a high value that the line conductors will be reduced to such a point that the increased cost of transformers and insulators, due to further increase in voltage will overbalance any saving in line conductors.

Assuming that the power is purchased at $10.90 per kilowatt year, and sold at $34, with a profit of 12 per cent., Mr. Mershon derives formulas from which he computes the maximum commercial distance to be about 550 miles.

Although the assumptions in the computations by means of which this result was reached involved conditions not existing in present practice, they are not farther beyond them than present conditions are ahead of those of a few years ago, and there is no good reason to consider them unattainable when they shall be required. At one time it was considered very desirable that electric power should be transmitted to long distances, but now it is realised that in most cases it is cheaper to place the manufacturing establishments closer to the source of power, and transmit the finished product to its markets. This may not always be the case, for all great water powers are not so conveniently situated as Niagara, and if the falls of the Zambesi are to be utilised, for instance, long distance transmission would be a necessity, at least for a long time to come.

Mr. Mershon is wise in stating the original conditions within which his forecast is made, since it is altogether possible that before the demand is made for transmissions of such magnitude and distance the methods may have become altogether changed. It is doubtless true that commercial and econoimic considerations will always rule in the ultimate analysis of any enterprise which depends upon commerce for its existence, but changing methods extend limitations in many ways. Thus any limitation in which the cost of the line wire is the ultimate element disappears at once if wireless transmission of energy becomes an accomplished fact, while the introduction of any such different system may bring with it other costs of a totally different nature. At the same time discussions such as Mr. Mershon has made are of great value, especially if they succeed in disposing of fictitious limitations, and direct the attention of engineers to the directions where improvements may best be made.

GLACIER PROTECTION WORKS.

REGULATION WORKS FOR THE CONTROL OF GLACIER STREAMS AND THE PREVENTION OF AVALANCHES IN UPPER SAVOY.

P. Mougin—Le Génie Civil.

ENGINEERING structures and operations have often been applied to control the movements of earth and regulate streams, and so it is entirely consistent that similar operations should be used to protect lands and habitations from the invasion of ice. In a recent issue of *Le Génie Civil* we note an article by Inspector Mougin, giving an interesting account of the works which have been made to guard against the dangers from the Tête-Rousse glacier, in Upper Savoy, and the subject is well worthy of notice and review.

The Tête Rousse glacier was almost unknown until the summer of 1892, being at the extreme south-west of the Mont Blanc chain, and separated from the greater and far more conspicuous basins of ice by the rocks of the Aiguille du Goûter, and by the larger Griaz Glacier. In July, 1892, the disaster of St. Gervais brought this glacier into notice by the sudden discharge of a torrent of water carrying a mass of débris down the valley in the middle of the night, destroying portions of the villages of Bionnay and Fayet, and the bathing establishment of St. Gervais, and causing a loss of 175 lives.

The glacier is not a large one, covering a little more than 10 hectares, or about 25 acres, but its peculiar position, filling an elliptical valley with but a limited outlet for the flow of ice causes it to offer material differences in behaviour from the action of the great glaciers having a free outlet for movement of ice and discharge of water.

Investigations by a party of engineers of the department of Streams and Forests led to the conclusion that some continuous outlet for the water from the Tête Rousse glacier was necessary for the prevention of further disasters, and the conduct of the work furnishes some interesting features in connection with this rather unusual department of engineering.

Vertical borings from the surface of the glacier showed that a body of water existed in the interior, and attempts were made to determine its depth by lowering weighted cords and measuring the wetted length of cord upon withdrawal. It was feared, however, that this method was unreliable, and suspected that the bottom of the cavity might be inclined so that the weight slid along until it met some obstruction, thus giving readings far too great. Attempts to use jointed sounding rods were but partially successful, since the end of the rod also slipped along the icy incline at the bottom of the water, and breakages were frequent. Finally sufficient data were collected, and plans were made to bore a tunnel through the rocky wall of the valley and into the heart of the glacier, thus tapping the accumulated water and providing an outlet over and through the Bionasset glacier, where it could do no harm.

This portion of the work required great care in order that the imprisoned body of water should not be tapped at a time when its first efflux might carry away the men engaged in the tunnel, and it was only by boring test holes into the heading after the ice was penetrated that the approach to the water was determined.

In July, 1904, the tunnel reached the water, and the discharge, at first delivered through a small bore hole, finally flowed through the larger opening made for it until nearly 20,000 cubic metres of water had been drained off. The engineers were then able to enter the cavity, which formed a large cave in the interior of the glacier. It was found that the peculiar position of the glacier, preventing its forward movement, except at a far slower rate than the other ice bodies in the Swiss valleys, rendered it difficult for the water to escape, while the body of ice and its superincumbent layer of snow acted as a sort of jacketing, preventing the collected water from freezing, the temperature of the interior being practically constant at 0° Centigrade. The water therefore accumulated until its pressure became sufficient to burst through the front wall of the glacier, carrying destruction before it.

The completed tunnel forms an excellent protection work, since it drains the cavity continually, the flow being moderate in amount, and diverted toward a direction where no harm can be done. The whole undertaking is an excellent example of protective engineering of a special and important kind.

RAILROAD ACCIDENTS IN AMERICA.

THE PRACTICAL WORKING OF THE TRAIN-ORDER SYSTEM AND THE BLOCK SYSTEM ON AMERICAN RAILWAYS.

H. D. Emerson—New York Railroad Club.

THERE appears to be no doubt that the question of accidents on railways in the United States are increasing in number, and that the attention, both official and popular, which is at present being given to the subject is the direct result of the manner in which the facts have impressed themselves upon thinking men. The article by Mr. Haskell, published in our December issue, has been the subject of much comment, and from other directions come various articles and papers upon the subject. At a recent meeting of the New York Railroad Club a paper was presented by Mr. H. D. Emerson, discussing especially the part which the present methods of train dispatching bear to the increase in railroad accidents, and some abstract of the paper is given as forming a valuable contribution to this present question.

"The statistics of the Interstate Commerce Commission tend to show that accidents are becoming more numerous on American railroads than formerly; that is, that the proportion of accidents to passengers carried is increasing. The Board of Trade reports for Great Britain indicate that in that country the reverse is true. Setting aside all academic discussions as to whether the Commission includes, in its comparative tables, passenger miles, train miles, total density of traffic or train movements, or makes sufficient allowance for the different conditions in England and America, the fact remains that it is not becoming progressively more dangerous to travel on railroads in Great Britain and that the opposite is true of America."

In a brief historical review Mr. Emerson shows the difference between British and American methods of operation to have grown out of the early methods used in both countries. In America the early use of the telegraph, in connection with single-track roads, soon developed into the train-order system, the engineer having a regular schedule for the siding and passing points, subject to telegraphed orders to do otherwise. In England, on the contrary, the germ of the block system appeared in the early use of a pilot man for each section, for whom a mechanical device in the form of the tablet or staff, was soon substituted, this leading to the use of mechanically operated semaphores.

Mr. Emerson discusses first the American train-order system, as applied to short, medium, and large lines, and shows very clearly how a method adapted for short lines and few trains becomes inadequate when extended to a scope far beyond its capabilities. In the case of a small road, of about 100 miles long, with two passenger trains, and one freight train in each direction a day, the operation is based on definite rules, easily memorized, and, in general, regularly obeyed. When a delay takes place, the dispatcher telegraphs to the conductor and engineer, and directs them to forget one particular thing which they had been instructed to remember at peril of death, and to remember something entirely new and different. This may not be a very serious thing on such a road as indicated, but when it is attempted to extend the same process to a line of 300 miles in length, with an average of five passenger trains and ten freight trains each way per day the possible number of meeting points for the passenger trains alone rises from four to twenty-five, and these must be memorized, again to be forgotten upon order. The number of crews, and the individual equation generally, will have risen proportionally much higher, and all attempt to retain any individual relations between the dispatcher and the train crews must abandoned. The result of this changed condition of affairs has been the evolution of the American Railway Association standard code, with its 23 rules and 13 forms especially applicable to single-track operation, all of which must be committed to memory by every dispatcher, agent, and trainman. Having these rules, the train order system still comes in to create confusion in case of emergency. If a train is, for any reason, delayed, orders are telegraphed by the dispatcher, and engineers, conductors, and brakemen, are alike required suddenly to forget the most vital and important lesson which they have learned, and to substitute for it a new lesson, to perform a new memory feat at peril of their lives. This is unquestionably the greatest weakness of the train-dispatcher's system. This is asking the man to sprint his distance in athletic competition and at the same time memorize his mathematical formulas—and not only memorize them, but put them into use while running.

When this system is extended to the case of a single-track main line, leading to the terminus of a large system, its break-down in case of emergency becomes inevitable. As Mr. Emerson says: train dispatching, as practiced, has elements of danger in excess of two to one at four different points, and at its worst the chances of wreck are simply terrifying to those who understand the possibilities. Turning now to the development of the block system in England its growth will be seen, with some reversals, to have progressed in the direction of safety instead of increased danger.

"After the traffic on the railroads in England became so congested that it could not be moved under the simple time-schedule arrangement, two methods were developed. The first is what is now known as the Tablet or Staff system. Under this arrangement the railroad was divided into sections or blocks, and each block was controlled by a tablet or staff. The engineman ran only when he had in his possession the staff which belonged to his particular block. This worked out so that the trains must be equal in number and must pass each other. That is to say, when a train was going north and the staff had been moved to the north end of the block no other northbound train could enter that block until the staff had been returned to the south end of the block From this worked out the staff and automatic system whereby the agent at the end of the block retained the staff and gave to the engineman a ticket which permitted him to pass through the block. This provided that when a number of trains were moving consecutively in the same direction the last train carried the staff to the other end. This system developed some of the same dangers as the train dispatcher or time system and resulted in rear-end collisions.

"To obviate this difficulty and permit the freer movements of trains, the staff or tablet system was developed. This provides for a box with a simple mechanical device at each end of the block, the two being electrically connected. Each box contains from ten to twenty tablets, or staffs. When one tablet or staff is removed from either box, both boxes are locked and no more tablets can be removed until the one in hand has been returned. Under this system the engineman knows absolutely that he has the sole right to the piece of track or block covered by the tablet or staff in his hand."

With increase in traffic manual blocking was adopted, both on single and double track roads, electric connection being provided between each end of the block. That systems on this basis are far more secure than the dispatching method is demonstrated by the small number of accidents occurring where it is faithfully employed. It has been objected to on the ground that it causes delays, but such an objection is simply to place convenience ahead of safety, and involves the admission that the length of the blocks is improperly calculated and the system imperfectly operated. It is true that wrecks have occurred on roads where the block system is used, but they are far less frequent, and as Mr. Haskell has observed, are largely due to failure to obey the requirements of the system.

"In England, with a much smaller mileage and a greatly denser traffic, fatalities are much less, proportionately, than they are in the United States. Is this not because the training of the engineman in the United States and the training of the engineman in England has been radically different? An English engineman has practically nothing to do with telegraphic orders. Before entering a block, and even before starting his train from a terminus, he knows definitely that the block is clear. He expects to be told by the indications of the signal: 'All right. Go ahead.'

"In operating on a single track with the tablet or staff system the very act of obtaining possession of the tablet or staff conveys to the English engineman a definite knowledge that he has the right to proceed. On the other hand, the American engineman has been educated to start his train on schedule time and to run and to look and to assume that everything is correct until he is told differently. Is it not true that his mental attitude of assuming that the signal will be clear when he shall reach it and that everything is right, causes many wrecks? If in each instance the engineman approached the block signal in a receptive frame of mind, expecting it to be against him and not passing it until he was definitely assured that it is not, would not a large percentage of the accidents which occur on blocked tracks be eliminated? The use of the staff system absolutely does away with the necessity of remembering orders or even of remembering the position of the signal at the end of the block. With the staff or tablet the engineman carries the signal with him, and he cannot only look at it and determine whether he has a right to be where he is, but he can also show it to others if he is called upon to prove his position."

CONDENSING MACHINERY.

THE DEVELOPMENT OF APPARATUS FOR THE PRODUCTION OF A VACUUM BY THE CONDENSATION OF EXHAUST STEAM.

William Edward Storey—Society of Engineers.

EVER since the invention of the separate condenser by Watt this portion of the power plant has been an important one, and although high-pressure non-condensing engines have been widely employed, the superior economy of the condensing engine has given it pre-eminence wherever sufficient water supply is available. In a paper recently presented before the Society of Engineers by Mr. W. E. Storey, the development of the condenser is examined at length, and some of the more important types now in current use compared.

In his original invention Watt seemed to have grasped nearly all the principles now in practical use, although he found the simple jet condenser and air pump best suited for operative conditions at his time. His original conceptions included the jet condenser with the wet air pump, the barometric condenser with the dry air pump, and the tubular surface condenser, with separate air and circulating pumps.

"Jet condensers are of two types, the parallel-current, in which the steam and cooling water flow into the upper end of the condenser and are, generally speaking, withdrawn by one wet air pump; and the counter-current, in which the water and steam inlets are as far separated as possible, the former being withdrawn by a separate water pump and the air by a dry air pump. The first of these types will be recognised as the one largely adopted in slow-speed stationary engine practice.

"Although Watt foreshadowed the type of jet condenser in which the air and uncondensed vapour are drawn off by a separate air pump, leaving the water to be dealt with by other means, the practical development of the counter-current type, which has these distinguishing features, has only taken place during the last few years, notwithstanding that it possesses advantages in economy in construction and motive power as well as in efficiency. As has already been said, the dry air pump, in this type of plant, draws its charge from the top of the condensing chamber at a point adjacent to the cooling water inlet, whilst the exhaust steam enters the chamber low down and near to the outlet of the cooling water. Baffle-plates are arranged in the interior of the condenser to ensure the complete mixing of the steam and water; the air and uncondensed vapour as they rise meet water increasing in coldness, until, at the point of education to the air pump, they are at or about the temperature of the incoming water.

"The absolute pressure in the condenser is the sum of the pressures of the air and steam, and is the same throughout the condenser. At the point of discharge for the hot water, the steam pressure must be that —or approximately that—corresponding with the temperature of the hot out-flowing water. Here, however, the water temperature is at its highest, and, consequently, the absolute steam pressure is the highest also. The result is that the air pressure at the same point must be correspondingly low, and, owing to its extenuation, its volume relatively increased. At the point of air pump suction it will be seen that exactly opposite conditions prevail. The temperature being approximately that of the incoming cold water the absolute steam pressure is considerably lower, whilst the air pressure is higher, the air denser and greatly reduced in volume.

"The saving in volumetric capacity of the air pumps due to this arrangement, as compared with those required to produce equal results in the ordinary parallel-current jet condenser, is as much as 40 per cent. As the duty of these pumps is simply to compress air, the expenditure of power will also be reduced in about the same ratio. Hence with this system using pumps of equal volumetric capacity, a higher vacuum may be obtained, or for a given vacuum, smaller pumps may be employed."

"Although the parallel-current jet condenser is occasionally arranged with separate dry air pump, the disadvantage remains that the air and vapour are drawn into the pump at the temperature of the hot water and, therefore, at the point of their greatest possible volume, so that little benefit arises from this arrangement."

The idea of using the barometric principle for the removal of water is older than the time of Watt, having been employed to drain the cylinders of the early Newcomen engines in which the injection water was delivered directly into the cylinder and no air pump employed. After the inductive action of the jet was brought into prominence by the invention of the Giffard injector, it was seen that a properly designed combination of nozzles and barometric discharge tube would form an effective condenser without requiring any air pump, and a number of such condensers have been designed. Where the water can be supplied with moderate lift no water pump is demanded, the flow being maintained by the suction of the vacuum, but in other cases a pump is used, the load upon it being materially reduced by the aid of the vacuum. These condensers have been applied with much success, and in recent turbine installations a vacuum of 27 to 28 inches has been maintained, according to the atmospheric pressure at the time.

Another form of barometric condenser is the so-called counter-current type, already referred to as having been indicated by Watt. A modern form is the Weiss condenser, in which the air is allowed to accumulate in the upper portion, to be drawn off by a dry air pump, while the water is carried off by gravity. Such arrangements are very efficient, and lower in first cost than the older types.

The surface condenser is the natural outgrowth of the desire to obtain a supply of pure water for boiler feed, this being especially important in marine navigation, where the salting of boilers is a serious objection to the use of sea water. .

The early surface condensers were made with straight tubes fitted to a closed chamber, the circulating water passing through the tubes and the steam being delivered outside. The fact that the best results were not obtained with arrangement has led to the belief that the contact between the water and the surface of the tubes might be improved. It has also been maintained that there is a tendency for the air to remain in contact with the outside of the tubes, and thus keep the steam away from the cooling surfaces.

In modern condensers various attempts have been made to improve the performance in these respects. In the Wheeler condnser internal return tubes are used for the water, thus keeping the colder water in contact with the tube surfaces; other designs involve the breaking up of the water, either by the use of annular passages, as in the Paul condenser, or by means of corrugated plates, as in the design of Ljungström. The efficiency of such devices is understood when the relative quantities of water demanded are given.

Thus, for land service, where cooling water is often scarce, or of comparatively high temperature, a square foot of cooling surface is generally provided in the condenser for every 8 to 10 pounds of steam condensed per hour. In marine practice, with unlimited cold water available, a much higher duty, say from 15 to 20 pounds per square foot per hour, is expected, while with the Ljungström arrangement as much as 70 pounds of steam per square foot per hour is condensed.

Mr. Storey refers to the use of evaporative condensers and cooling towers for use where the supply of condensing water is limited, and also discusses the important matter of the corrosion and pitting of tubes. At the present time the corrosion of tubes is a question demanding solution, and the discovery of an alloy which can readily be drawn into tubing and which will not pit in service is greatly to be desired.

The construction and operation of various forms of air pumps is given attention in the paper, and a comparison of the early pump of Bodmer with the modern Edwards air pump shows that the advantage the principle was well known and clearly worked out as long ago as 1845.

"The great influence of a high vacuum on the steam consumption of the steam turbine has led to other devices for improving the vacuum being worked out by different engineers. Parsons has secured the desired result by dividing the air pump suction pipe into two parts, taking the water down one portion and the air down the other, the point of education from the condenser being for the latter, considerably higher in the condenser than that for the former. In the air pipe he inserts a steam jet which assists the air pump by partially compressing the air and vapour at the point of delivery to the air pump. By this means, whilst the vacuum in the condenser may be so high as 29 inches, at the inlet to the air pump it will be about 25½ inches, this result being effected by the use of a steam jet of an initial diameter of only 5-16 inch. It is obvious that with this simple device the efficiency of the air pump is greatly increased and that for a given duty its size may be relatively reduced."

"The improvement of the air pump efficiency by making the air and vapour more dense has also been attempted by other means. For instance, by retaining in the bottom of the condenser a body of the water of condensation, the temperature of which is kept below that of the vapour due to the pressure in the condenser, and then drawing the air and vapour to the air pump over the cool surface of this water, a somewhat greater density is secured for the pump suction charge; but it is problematical whether the contact of the air and the water is sufficiently intimate to produce a really appreciable result."

A comparison of the vacuum attained in the condenser with that realized in the cylinder has emprasised the importance of employing large exhaust pipes and free discharge of the steam into the condenser.

This is fully appreciated by the builders of steam turbines, the condenser, in more than one design, forming practically a continuation of the low-pressure end of the machine.

In connection with the subject of the production of vacuum for steam engines, we may call attention to the desirability of referring to the result in terms of absolute back pressure rather than in inches of vacuum. The fluctuations of atmospheric pressure, as shown by the barometer, render statements of vacuum in inches of mercury unavailable for comparison unless the statement of the height of the barometer at the time and place is also given. By taking the difference between the condenser and the atmospheric pressure at any time, expressed in pounds per square inch, we have the absolute back pressure in the same terms as the initial steam pressure, and data which are immediately comparable are obtained.

HIGH-SPEED MOTOR BOATS.

THE INFLUENCE OF POWERING, PROPELLERS, AND HULLS UPON THE SPEEDS ATTAINABLE WITH SMALL BOATS.

A. Tellier.—Société des Ingenieurs Civils de France.

APART from the importance of the development of mechanically propelled vehicles on common roads, the efforts to produce light and powerful motors for automobiles have resulted in effecting an unexpected influence upon other methods of locomotion. There is no doubt that the recent progress which has been made in dirigible balloons is entirely due to the improvements which have made possible the reduction in weight of the internal-combustion motor, and, in like manner, the so-called motor-boat, an unfortunate appellation for an otherwise nameless craft, owes its existence to the development of this same high-speed, light-weight engine.

In a paper presented recently before the *Société des Ingenieurs Civils de France* by M. A. Tellier, fils, some valuable information is given about the construction and performance of some small racing boats propelled by gasoline motors, and the manner in which the data and results are presented renders the information of more service than is usual. The trials recorded in the paper extend over a period of three years, and include information about boats of different designs, using various motors and propellers. Apart from the direct value of the information thus gathered, it may be useful for consideration in connection with the extravagant statements sometimes made, such as the prediction that internal-combustion motors may soon be expected to replace steam engines for torpedo-boat propulsion, whereas the largest engines of the internal-combustion type operating regularly in such boats do not exceed 150 horse power in capacity.

The first boat considered by M. Tellier is the Lutèce, built at the close of 1901. This is a vessel of 15 metres length, with a hull of cedar, having a displacement of two tons (metric), the hull itself weighing but 600 kilogrammes, or only 30 per cent. of the total displacement. The Lutèce was originally equipped with two four-cylinder Panhard motors, each of 40 horse power, arranged with a magnetic coupling and differential speed gear. The propeller had three blades, the generatrix being perpendicular to the axis, the diameter being 0.7 metre. Under these conditions, with both motors in operation, at a speed of 850 revolutions, a speed of 18.4 knots was attained. Although the weight of the motors was only 7.5 kilogrammes per horse power, this soon was found heavy by comparison with later machines, and in 1903 the boat was fitted with an improved Panhard motor, giving 80 horse power with one four-cylinder engine at 900 revolutions, this machine, including the fly wheel, weighing only 300 kilogrammes, or 3.75 kg. per horse power, or one-half that of the old motors. Although an improvement in working was apparent, the speed was not materially increased until the old propeller was replaced by an improved design, with increasing pitch, the generatrix being inclined 10 degrees aft to facilitate the contraction of the liquid vein. Under these conditions the speed attained was 19.5 knots, the trials giving the same result as had been attained by calculation.

M. Tellier gives some data concerning the boat La Rapée II, of 8 metres in length and a displacement of 0.8 metric ton, this making a speed of 16.25 knots with an indicated power of 33 h. p., and then proceeds to describe a still later model, La Rapée III, built in February, 1904. This hull is an example of the tendency to place the greatest cross section further and further aft, the hull resembling an elongated flatiron, with the greatest part at the stern. The midship section is almost circular, flattening rapidly toward the rear, the hull being absolutely flat at the stern. With this shape the water leaves the hull tangentially without showing either contraction or suction.

The Rapée III, with a length of 7.88 metres and a total displacement of 1.158 metric tons, made a speed of 18.4 knots. The motive power under these conditions was a Panhard-Levassor four-cylinder motor, giving 40 horse power at 900 revolutions, the weight being 5 kilogrammes per horse power. This engine was then replaced by one similar to that of the Lutèce, and a new propeller was also fitted. These changes were computed to make possible a speed of 21.8 knots, and this speed was attained on trial with 960 revolutions per minute of the engine.

M. Tellier gives data concerning trials of several other boats, including the Princesse Elisabeth, the Titan II, the Hotchkiss, and the Pertuisane, the results comparing well with those already cited. In general the progress made by reason of the experience of the past few years is clearly marked by these results. The reduction in weight is a notable element, and it is interesting to compare the Rapée III with the Turbinia, this latter boat representing the most remarkable results which have been attained with steam propulsion. Thus the Rapèe III has a powering of 80 horse power per ton of displacement, with a total weight-ratio of all machinery of only 6.25 kilogrammes per horse power. The Turbinia, on the contrary, has only 21.2 horse power per ton of displacement, and the machinery weighs 23.6 kilogrammes per horse power. If the Deutschland, for example, be compared with the Rapèe III by the law of similitude she would develop the enormous speed of 110 knots.

The principal criticism which has been made of the mechanical features of these little boats has been directed towards the motors. Their speeds of rotation have been considered enormous, ranging from 800 to 1,500 revolutions per minute, but, as a matter of fact, the actual piston speeds are lower than those of torpedo-boat engines or express locomotives, and the weight of the reciprocating parts is proportionally much lighter. M. Tellier maintains that such motors give little or no trouble in operation, and cites the fact that in the races at Monaco the engines of the Rapèe III were operated for six consecutive hours at 950 revolutions per minute, or a total of 342,000 consecutive revolutions, and, as there are four cylinders, there were 684,000 explosions. The speed of the boat over the sixteen laps of the course did not vary more than three seconds per lap, showing the uniformity of the motive power under these trying conditions.

M. Tellier considers that further improvements are to be looked for in connection with the design and construction of the propellers for the peculiar conditions required, and the results already obtained with these small screws at high rotative speeds gives encouragement for future improvement in this direction.

So far as the form of hull is concerned, it is interesting to note the differences which have developed in comparison with the models of high-speed steamboats. The practical results are altogether contrary to the famous wave-line theory of Colin Archer and Scott Russel, with sinusoidal bow and trochoidal stern. The facts are that the motor boat does not cut the water, and thus act to displace it; rather may it be said to plane the surface of the water, becoming thus a sort of hydroplane, analogous in design and action to that of the aeroplane. It is by a consideration of these differences in operating conditions that still higher speeds may yet be attained.

Down to the present time the improvements which have been made in these high-speed motor-boats have had the same end in view as in the case of automobile vehicles —the production of racing machines for sporting purposes. The recent endurance trials in England, however, have shown that such boats may be made useful auxiliaries for general marine and naval service.

CHROME-VANADIUM STEEL

IMPORTANT HEAT-TREATMENT EXPERIMENTS UPON ALLOY STEELS CONTAINING CHROMIUM AND VANADIUM.

Institution of Mechanical Engineers.

WE have referred in these columns to the experiments which have been made upon the influence of the addition of vanadium to steel, and the researches of M. Guillet have been especially considered as important. We now have a paper presented before the Institution of Mechanical Engineers by Captain H. Riall Sankey and Mr. J. Kent Smith, giving the results of some very important experiments upon steels containing both vanadium and chromium. The paper consisted largely of tabular matter, and it is impossible to give more than an abstract of the substance of the results in this place, but the remarkable character of the product gives much interest to the subject.

In the first place it appears that the addition of both chromium and vanadium to steel gives a product possessing in a very high degree the properties of strength and ductility. With an ultimate strength of 54 tons per square inch, and a yield point of 37 tons there was obtained an elongation of 25 per cent. in 2 inches, and an area reduction of 50 per cent. Under impact tests and rapidly alternating stresses according to the method of Professor Arnold results were obtained practically twice as high as those given by a good quality forging steel. The material was also subjected to metallographical examination, and especially to various forms of heat treatment, and it was mainly to this latter subject that the paper was devoted.

In the latter part of 1903 a paper was presented before the Iron and Steel Institute by Mr. J. E. Stead, and reviewed in these columns in November of that year. Briefly the method of Mr. Stead included the determination of a reheating temperature to which brittle steel should be raised, and from which it might be allowed to cool in the open air, this operation restoring it to proper working condition. This reheating temperature, according to Mr. Stead, is about 900° C., and it was his experience that any steel which had been made brittle by improper treatment could be completely restored by heating to about 900° C. for a short time and allowed to cool in the air, this operation making the material better, if anything, than it had ever been.

Applying this operation to the chrome-vanadium steel it was found that the ductility was increased, although the ultimate resistance was somewhat diminished. After such a treatment the ultimate resistance was 38.5 tons, the yield point 21 tons, while the elongation was increased to 34 per cent., with a reduction of area of 53 per cent. Both the torsional and the bending tests showed a material improvement, the material being fully as good as nickel steel. With these improvements come also increased resistance to alternating stresses and to impact, so that the material is in every way remarkable. These results are still further improved by oil tempering.

Thus, by oil quenching at 900° C. and then tempering at 600° C. an ultimate resistance of 53.6 tons is secured, with a yield point of 43.4 tons; the elongation being 22 per cent. and the reduction of area 56 per cent.

Experiments have also been made to show the applicability of these steels for cutting tools, and it appears that good cutting tools were made by heating to a high temperature and quenching, while a high grade of springs steels were also made of the material.

The utility of Mr. Stead's method of restoring burnt steel was fully demonstrated with the chrome-vanadium steel, specimens being soaked for several hours at 1,200° C., and shown to be seriously injured, and then fully restored by reheating.

An interesting feature about these tests was the care and thoroughness with which they were conducted. The heating was performed in an electrically heated muffle, this enabling the temperatures to be kept fully under control, while the temperature observations were made by means of an electric resistance thermometer, connected to a Callendar and Griffith record. The recalescence determinations, results of which are given in the original paper, were obtained by the use of a carefully standardised couple, an efficient vacuum being maintained in the furnace chamber containing the piece of metal under observation, using a delicate galvanometer and a chronograph recorder. The tensile tests were made upon a Buckton 30-ton machine, with a Wicksteed recorder, and the alternation tests were conducted by Professor Arnold himself, so that the results may be accepted as trustworthy.

In the course of the discussion some additional points of interests with regard to the material were brought out. Thus, the resistance of the raw material to alternations was so good that no treatment was necessary, but if resistance to both alternations and impact are desired the steel should be annealed. The raw steel gives also extreme elastic resistance, combined with static ductility, while by annealing some of the static resistance is sacrificed to obtain static ductility and impact resistance. If both qualities are required it is necessary to resort to oil tempering.

In regard to the relative influence of vanadium and chromium upon the material, it was stated that experiments were made by using various chromium steels and then adding vanadium. With chromium alone very good results were obtained on static test, a strength of 38 tons being obtained with 1 per cent. of chromium. The simple addition of a small amount of vanadium increases the static strength about half as much again, and it was possible to get very much higher maximum strength by increasing the chromium.

The remarkable results which were shown by the tests tabulated in the paper, and the great interest apparent in the discussion may be taken as an indication of what may be expected in the further development of this question of alloy steels. With the materials now available for making ternary and multiple alloy steels there is such a large number of possible combinations that we may expect continual additions to the list of new materials of construction. Thanks to the electric furnace and to improved methods of isolation, materials which were formerly classed among the curiosities of the chemical laboratory and museum have become available for the production of new alloys in commercial quantities, and the results are only beginning to be appreciated. When to the supply of new material we add the command of improved apparatus, such as has been employed in the researches of the authors of the paper under review, enabling quantitative and controlled temperature effects to be produced, it will be realised that the scope of research is practically unlimited.

TESTING OF AMERICAN COALS.

A DESCRIPTION OF THE PLANT AND METHODS OF THE UNITED STATES GEOLOGICAL SURVEY AT THE ST. LOUIS EXPOSITION.

Prof. L. P. Breckenridge—Power.

NEARLY sixty years ago a number of tests of American coals were made by Professor Walter R. Johnson for the American navy, and it is a tribute to the accuracy of this work that the results have been accepted and generally confirmed by experience since that time. These tests, however, were limited in number and scope, and the need for something more modern and extensive has long been realized. Under these circumstances the fact that a new and complete series of tests of American coals was to be made at the St. Louis exposition, under the auspices and management of the United States Geological Survey, has found welcome and encouragement from mechanical engineers and steam users. This work is by no means completed, but from a paper in a recent issue of *Power,* by Professor L. P. Breckenridge, we give some account of the plant and the general method of operation.

The plans include tests of the coals under five different applications, namely: under steam boilers; in gas producers and gas engines; in coke ovens; in briquetting machines; and by chemical analysis and in the calorimeter. It will be seen, therefore, that the data thus obtained will be of the greatest practical as well as scientific use, furnishing information as to the relative availability of various coals for different purposes, and also checking the results of laboratory methods by the larger scale trials in the actual processes of service.

The apparatus, described in detail by Professor Breckenridge, includes two Heine water-tube boilers of 210 horse power each, a gas producer, gas holder, and auxiliary apparatus, by R. D. Wood & Co., a three-cylinder Westinghouse gas engine of 250 horse power, coke ovens, briquetting plants, coal handling plant, chemical laboratory, Corliss engine, electric generators, and numerous electric motors, jigs, crushers, scales, boiler test appliances, and computing machines.

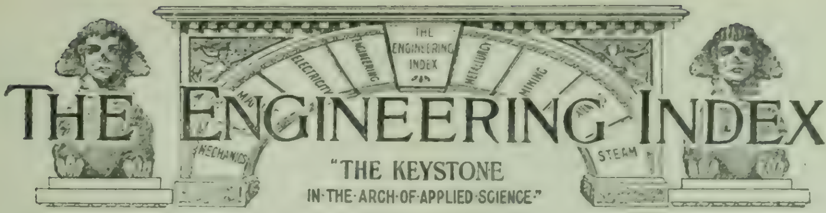
In the tests of coals under the steam boilers every care has been taken to render the conditions identical, so that the differences in the results may be those due only to the coals under test. The two boilers are set in exactly the same manner, and there are independent chimneys, and separate feeding apparatus. The testing is in the hands of a mechanical engineer in charge, under whom there are four observers in the boiler room—one for weighing coal, one for weighing the feed water, one for the general observations, and one for the gas analysis. The computations pass through the hands of two independent computers, in order that the results may be adequately checked. All the observers and computers are skilled men, of extended experience in similar work.

In general the methods indicated in the boiler test code of the American Society of Mechanical Engineers have been applied to the tests of the coals under boilers. The water and the coal are carefully weighed, the temperatures taken with standardized thermometers and pyrometers, while the draft readings are determined by carefully tested gauges. The flue gases, drawn for analysis, are taken by means of a sampling box arranged as closely as possible according to the method indicated in the code, using a number of tubes of different lengths in a box. Gas samples have also been taken simultaneously with a single perforated tube, with the object of determining the difference, if any, of the two methods.

The care which has been taken with all the details of the operation, and the publicity which has been given, is ample assurance that the work is being done with every care as to accuracy, and entire freedom from influence of private interests. The car loads of coal sent from the various mines have been certified to as to their origin and representative character, and the source kept unknown during the operations of testing, while the fact that the United States Geological Survey is responsible for the results gives an official character to the tests which frees them from any proprietary interests. The tests of coals under boilers are of ten hours' duration, so that ample time is given for a fair average result.

The conditions under which the machinery and apparatus were installed rendered it impossible for the work to be commenced before the latter part of August, and in consequence there is a general desire that it should not be discontinued because of the closing of the exposition. About fifty car loads of as many different kinds of coal have been tested, the varieties coming from widely separated fields and much of it from new fields. It is now hoped that a further appropriation may be obtained from the government for the continuance of this important work, and efforts are already being made to this end.

This question of the properties of standard coals is one of far-reaching importance, and it would be a matter of grave regret should the work so auspiciously begun be permitted to remain uncompleted. It is also undesirable that it should be conducted by means of private contributions unless the conduct of the work remains in the hands of the Geological Survey in such a manner as to give it the status of official government sanction. Apart from the classification of the coals by the calorific power, such a system of testing enables the best uses of the different fuels to be determined, and gives the engineer positive knowledge of the proper coals to use, not only for steam making, but also for use in metallurgical operations and for the production of fuel and power gas.



THE ENGINEERING INDEX

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(5) Where published,
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DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING 843
ELECTRICAL ENGINEERING 848
INDUSTRIAL ECONOMY 854
MARINE AND NAVAL ENGINEERING..... 855
MECHANICAL ENGINEERING 856
MINING AND METALLURGY............. 865
RAILWAY ENGINEERING 870
STREET AND ELECTRIC RAILWAYS....... 873

CIVIL ENGINEERING

BRIDGES.

Abutment.

Concrete Abutment on the Ulster & Delaware. M. H. McGee. Illustrated description of a concrete abutment and long wing wall for a plate girder skew bridge. 500 w. R R Gaz—Vol. XXXVII, No. 25. No. 66445.

Drawbridge.

Details at the Pivot Pier and Ends of the Merrimac River Drawbridge, Newburyford, Mass. Illustrates and describes the operating mechanism, loading system and electric connections. 1400 w. Eng Rec—Dec. 17, 1904. No. 66689.

Frames.

The Computation of the Cross Frames of Iron Bridges (Beitrag zur Berechnung der Querrahmen Eiserner Brücken). F. Brunner. A very complete graphical analysis of the transverse stresses on bridge trusses for various loadings. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 9, 1904. No. 66824 D.

Highway Bridge.

The Schell Memorial Bridge. Illustrated description of a highway bridge across the Connecticut River at Northfield, Mass. 1500 w. Eng Rec—Dec. 17, 1904. Serial. 1st part. No. 66684.

We supply copies of these articles. See page 876.

The South Tenth Street Bridge, Pittsburg. Illustrated description of a five-span steel structure, 1,417 ft. long. 2000 w. Eng Rec—Dec. 10, 1904. No. 66612.

Plate Girder.

Erection of a Plate Girder Bridge with a Gin Pole. J. W. Philips. Illustrated description of an interesting work in connection with the Lackawanna improvements in Newark, N. J. 700 w. R R Gaz —Vol. XXXVII, No. 29. No. 66955.

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Concrete Steel Bridge at Plano, Ill.; Chicago, Burlington & Quincy Ry. Illustrated description of a double-track bridge 44 ft. wide, with an arch of 75 ft. span, and having wing walls which bring the total length to about 212 ft. 1400 w. Eng News—Dec. 22, 1904. No. 66763.

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Structural Details of the New Reinforced Concrete Bridge at Grand Rapids, Mich. William F. Tubesing. Illustrated description of details of construction. 2300 w. Eng News—Dec. 1, 1904. No. 66422.

The Grünwald Bridge Over the Isar (Die Isarbrücke bei Grünwald). Prof. Mörsch. Detailed description of reinforced-concrete bridge, with two hinged arches of 70 metres span, across the Isar at Munich. Two articles. 4000 w. Schweiz Bauzeitung—Dec. 3, 10, 1904. No. 66848 each B.

See Also Civil Engineering, Construction.

Rhine.

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Suspension.

Anchorages for the Manhattan Bridge. Illustrated description of the plans for the anchorages on both sides of the East River for the Manhattan Bridge between New York and Brooklyn. 900 w. R R Gaz—Vol. XXXVII, No. 27. No. 66671.

CONSTRUCTION.

Beams.

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Industrial Buildings.

The Engineering of Industrial Buildings. D. C. Newman Collins. Discusses the development of building plants, the cost of maintenance, etc. 2500 w. Ir Age —Dec. 1, 1904. No. 66468.

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A Concrete Steel Dam at Danville, Ky. Illustrated description of an interesting dam built across the Dix River to impound a water supply. 700 w. Eng Rec—Dec. 3, 1904. No. 66478.

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Construction and Strength of Reinforced Concrete Columns. W. Dunn. Considers the necessary tests to secure reliable material and the strength of the material in place, giving results of experiments, etc. 9800 w. Jour Roy Inst of Brit Archts—Nov. 26, 1904. No. 66931 D.

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Construction and Strength of Reinforced Concrete. W. Dunn. Read before the Roy. Inst. of Brit. Archts. Abstract. Deals with the essentials of reliable material, the process of mixing, the strength, method of construction, etc. 1800 w. Archt, Lond—Nov. 25, 1904. No. 66522 A.

Monolithic Constructions in Hennebique's Ferro-Concrete. L. G. Mouchel. An illustrated discussion of ferro-concrete constructions and the general principles on which they are based, the theory of the Hennebique system, the use of this material, and related matters. Ills. 7500 w. Jour Roy Inst of Brit Archts—Nov. 26, 1904. No. 66932 D.

Directions for Making Concrete-Steel Slab Culverts and Bridges. Abstracted from Bul. No. 7, N. Y. State Engineer. Directions for the work, illustrating details. 800 w. Eng News—Dec. 29, 1904. No. 66941.

Six-Story Reinforced-Concrete Factory Building in Brooklyn. Illustrates and describes a fireproof structure designed to carry light machinery on every floor. 1800 w. Eng Rec—Dec. 10, 1904. No. 66613.

The Reinforced Concrete Building of the J. M. Bour Co., Toledo. George V. Rhines. Illustrations, with description of a warehouse and roasting plant constructed entirely of concrete reinforced with plain steel rods. 2700 w. Eng Rec—Dec. 24, 1904. No. 66782.

See Also Civil Engineering, Bridges.

Retaining Wall.

A Concrete Wall Eleven Years Old. Illustration and data in regard to a retaining wall on the Coast division of the Southern Pacific. 900 w. R R Gaz—Vol. XXXVII. No. 26. No. 66557.

See Also Reinforced Concrete.

Roads.

The Oiled Roads of California. Information from a recently issued bulletin presenting all the available data in regard to oiled roads in the State. 5000 w. Eng Rec—Dec. 1, 1904. Serial. 1st part. No. 66477.

MATERIALS OF CONSTRUCTION.

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What Can Chemical Research Do for the Portland Cement Industry? Extracts from an address by Mr. Clifford Richardson at the annual dinner of the Assn. of Portland Cement Mfrs. Considers how chemical research can be best carried on, and some of the problems it may be depended upon to assist. 3000 w. Eng Rec—Dec. 24, 1904. No. 66786.

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Hardening.

The Conditions Hydration and Hardening (Ueber Hydratations und Erhärtungsvorgänge). Dr. P. Rohland. A study of the conditions of hardening of plasters, cements, mortars, etc. 4000 w. Zeitschr f Elektrochemie—Nov. 25, 1904. No. 66875 D.

Timber.

The California Redwood in Modern Engineering. H. A. Crafts. An account of some of the uses to which the redwood is put in California. Ills. 1000 w. Sci Am—Dec. 3, 1904. No. 66451.

The Strength of Structural Timber. A summary of the investigations being made by the U. S. Dept. of Agriculture, under the direction of W. K. Hatt, with editorial comment. 2600 w. Eng Rec—Dec. 24, 1904. No. 66783.

Timber: Its Strength, and How to Test It. Prof. T. Hudson Beare. Abstract of a lecture delivered before the Dundee Inst. of Engrs. Gives tabulated report of tests made, with remarks on previous investigations, and the value of tests. 1000 w. Engng—Dec. 9, 1904. No. 66731 A.

MEASUREMENT.

Grain Pressure.

Tests of Grain Pressure in Deep Bins at Buenos Ayres, Argentina. Eckhardt Lufft. Gives a summary of results of tests carried out from Feb. to Nov., 1903. Ills. 3000 w. Eng News—Dec. 15, 1904. No. 66662.

Stream Gagings.

Notes on the Computation of Stream Gagings. O. V. P. Stout. An explanation of the Harlacher method of computing discharge. 1000 w. Eng News—Dec. 8, 1904. No. 66555.

The Measurement of Running Water in Rivers and Open Channels. W. H. Wheeler. An illustrated article reviewing methods of estimating, and especially considering recent work in the United States. 5000 w. Engr, Lond—Dec. 9, 1904. No. 66733 A.

Stadia.

The Stereoscopic Measuring Apparatus (Das Stereoskopische Messverfahren). A. Freiherr v. Hübl. Describing the application of exaggerated stereoscopic effects to the measurement of distances, with especial reference to the apparatus of Dr. Pulfrich. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 25, 1904. No. 66820 D.

Surveying.

How the Massachusetts Northern Boundary Was Run Without Random Lines. N. Spofford. An account of the use of tall signal poles through land covered with a heavy growth of wood and timber. 2000 w. Eng Rec—Dec. 10, 1904. No. 66616.

The Three-Point Problem in Plane-Table Surveying. Antonio Llano. Describes Bessel's method for the graphic solution of this problem in the field. 1500 w. Eng News—Dec. 29, 1904. No. 66944.

Topography.

Stereoscopic Topography (Sur la Téléstereoscopie). Paul Helbronner. An account of the application of stereoscopic photography with telephotographic lenses to views in the French Alps to aid in topographical work. 1500 w. Comptes Rendus —Dec. 5, 1904. No. 66845 D.

MUNICIPAL.

Address.

Municipal Engineering on the Continent. W. H. Lindley. Summary of the presidential address to the Junior Inst. of Engrs. Considers waterworks, sewerage works, electric lighting, and other works. 2700 w. Mech Engr—Nov. 26, 1904. No. 66525 A.

Cesspools.

A Successful Dry Well. An illustrated description of a sanitary arrangement for taking care of house sewage where no sewers are available. 1200 w. Met Work —Dec. 3, 1904. No. 66447.

Refuse Destruction.

See Mechanical Engineering, Steam Engineering.

Septic Tanks.

Septic Tank Sewage Disposal. A record of the practical working of the system, based on six years' experience. 3000 w. Munic Jour & Engr—Dec., 1904. No. 66485 C.

The Septic Tanks at Greensboro, N. C. W. G. Potter. Brief description of the construction of septic tanks where peculiar difficulties were encountered. Ills. 1200 w. Eng Rec—Dec. 10, 1904. No. 66614.

Sewers.

Sewer Reconstruction in Connection with the New York Rapid Transit Subway. An account of the difficult work of diverting and replacing the sewers on the line of the subway. 2700 w. Eng Rec—Dec. 17, 1904. No. 66688.

Sewer Siphons in Brooklyn, N. Y. Illustrates and describes some interesting details of design and construction made necessary in rearranging the sewers on the line of the rapid transit subway. 1400 w. Eng Rec—Dec. 3, 1904. No. 66472.

The Main Intercepting Sewers of Cleveland, Ohio. Walter C. Parmley. An account of this undertaking and some of the engineering features and problems connected with it. Ills. 9500 w. Jour Assn of Engng Socs—Nov., 1904. No. 66698 C.

The Sewers of Little Rock, Ark. E. A. Kingsley. Concerning the sewerage system and drainage. 1000 w. Munic Engng —Dec., 1904. No. 66655 C.

Tools Used in Cleaning Sewers. Ben. E. Briggs. Illustrates and describes tools used at Erie, Pa. 900 w. Munic Engng— Dec., 1904. No. 66653 C.

Towns.

The Construction of Towns. Prof. L. Cloquet. Deals with the planning of a town, the street design, and the public places. Plans. 3000 w. Engng Rev—Dec., 1904. Serial. 1st part. No. 66720 B.

WATER SUPPLY.

China.

Shanghai Water-Works. Illustrated description of the pumping station and a set of engines which have recently been installed. 2500 w. Engr, Lond—Dec. 16, 1904. No. 66928 A.

Conduits.

The Wood-Stave Conduit for the Water Supply of Atlantic City. Kenneth Allen. An illustrated detailed description of the construction work, with notes and discussion. 6500 w. Jour N Eng W-Wks Assn—Dec., 1904. No. 66750 F.

Filtration.

The American System of Filtration Plant in Mysore, India. Edmund B. Weston. An illustrated description of the works for supplying the Kolar gold field with potable water. 4500 w. Eng Rec—Dec. 17, 1904. No. 66682.

The Philadelphia Filtration System. Illustrated detailed description of the siphon of the Torresdale tunnel conduit, which carries the filtered water to Lardner's Point. 3000 w. Eng News—Dec. 1, 1904. No. 66423.

Holyoke.

The Holyoke Water Supply. A. M. French. Gives the history of its conception, birth and continuous growth up to its present magnificent system. Map. 6300 w. Jour N Eng W-Wks Assn—Dec., 1904. No. 66751 F.

Irrigation.

Tests of Irrigation Pumping Plants and Wells in the Valley of the Rio Grande. Charles S. Slichter. Describes tests made in New Mexico and Texas, giving tabulated results. 2500 w. Eng News—Dec. 29, 1904. No. 66940.

Mains.

Laying a Submerged Water Main at Waterville, Me. Illustrates and describes the unusual method used in laying a 20-in. water main under the Kennebec River. 1000 w. Eng Rec—Dec. 17, 1904. No. 66687.

New York.

Additional Water Supply for New York City. Rudolph Hering. An interesting statement of the conditions in Greater New York, with report of recent investigations in regard to future increase of the supply, the quality of the water, cost, etc. Map. 5400 w. Jour N Eng W-Wks Assn—Dec., 1904. No. 66749 F.

The Condition of the Croton Water-Works, New York. Gives a diagram showing graphically the value of work done each year from 1895 to 1904, inclusive, with comments on the information given in the recent report of J. Waldo Smith, chief engineer. 2500 w. Eng Rec—Dec. 24, 1904. No. 66784.

Reservoirs.

Failure of a Reservoir Bottom at Red Wing, Minn. F. H. Bass. Brief illustrated description of a peculiar failure. 500 w. Eng News—Dec. 8, 1904. No. 66556.

Revenue.

Municipal Water Supply Revenue. James L. Tighe. Discusses the equity of using this revenue for meeting the expenses of government. 2700 w. Jour N Eng W-Wks Assn—Dec., 1904. No. 66748 F.

Stand Pipe.

A Stand Pipe Failure at Sanford, Me. Charles W. Sherman. An illustrated account of the failure of a 40 x 80 ft. steel stand pipe on Nov. 17, 1904. 1000 w. Eng News—Dec. 1, 1904. No. 66425.

Turbidity.

A New Method for Determining the Color of the Turbidity of Water. Freeland Howe, Jr. Describes a method by which the color can be expressed mathematically and can be reproduced at any time or place. 1200 w. Eng Rec—Dec. 17, 1904. No. 66686.

Typhoid.

The Epidemic of Typhoid Fever in Ithaca, N. Y. George A. Soper. Gives statistics of this epidemic, discussing the theories of the cause and the corrective measures undertaken. Discussion. 11200 w. Jour N Eng W-Works Assn—Dec., 1904. No. 66753 F.

The Longevity of the Typhoid Bacillus in Water. George C. Whipple. Reviews recent papers by Dr. William Dodge Frost, and a joint paper by Dr. E. O. Jordon, Dr. H. L. Russell, and Dr. F. R. Zeit. 4000 w. Eng Rec—Dec. 24, 1904. No. 66785.

Water Rights.

Water Rights in California. Samuel C. Wiel. The present article reviews the history of the law of water in California. 1500 w. Min & Sci Pr—Dec. 17, 1904. Serial. 1st part. No. 66795.

WATERWAYS AND HARBORS.

Alexandria.

The Harbor of Alexandria (Le Port d'Alexandrie). G. Birault. An account of the development of the modern port since 1832, and of the present and projected harbor improvements at Alexandria, Egypt. 3000 w. Génie Civil—Dec. 10, 1904. No. 66825 D.

Canals.

A Description of the Truckee Main River Canal. George Shuey. An illustrated description of this irrigation project in Nevada. 1700 w. Cal Jour of Tech—Oct., 1904. No. 66419 C.

The British Canals Problem. Arthur Lee. Discusses the policy adopted on the Continent, and the policy of the British Railway Companies, and the importance of the matter. General discussion follows. 11500 w. Jour Soc of Arts—Dec. 2, 1904. No. 66620 A.

The Lesson of the German Water-Ways. O. Eltzbacher. A comparison of the cost of transport in Germany and Great Britain, showing the value of waterways, and discussing other causes tending to industrial success. 8500 w. Contemporary Rev—Dec., 1904. No. 66715 D.

Electric Haulage.

Electric Haulage in Germany. Clarence B. Schultz. Facts concerning the Teltow Canal, near Berlin, Germany, describing the system of traction, the machinery adopted, etc., giving a financial review of the different electric haulage systems. Ills. 4000 w. Marine Engng—Dec., 1904. No. 66548 C.

Locks.

Canal Locks Considered as Inclined Planes (Ueber Schleusentröge auf Quergeneigter Ebene). Fr. Jebens. A consideration of the inclination of the surface of the water in canal locks, due to the effect of the movement of the water. 1500 w. Glasers Annalen—Dec. 15, 1904. No. 66831 D.

Panama.

The Present Aspect of the Panama Canal Construction. Wm. H. Burr. A general account of the existing conditions and plans for work at the isthmus. 3500 w. Engineering Magazine—Jan., 1905. No. 66888 B.

Pier.

The Landing Pier at Lome (Die Landungsbrucke in Lome). K. Preiss. A fully illustrated description of the erection of a steel pier at Lome, on the west coast of Africa, in the German colony of Togo. 3500 w. 2 plates. Zeitschr d Ver Deutscher Ing—Nov. 26, 1904. No. 66812 D.

Stream Beds.

The Natural Equilibrium of the Beds of Flowing Streams (Untersuchung über die Naturliche Gleichgenrichtform Beweglicher Flussbetten). F. Kreuter. A discussion of the proper form to be given to artificial river banks in regulating and controlling streams. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 25, 1904. No. 66821 D.

Trieste.

The Harbor of Trieste (Der Hafen von Triest). Eduard Michl. A general account of the development of the port, with description and plan of the proposed improvements of the harbor and railway terminals. 4000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver—Nov. 11, 1904. No. 66816 D.

MISCELLANY.

Japan.

Notes of an Engineer in Japan. W. E. Crane. Briefly describes the irrigation works, canals, railroads, highways and bridges. water supply, sanitation, garbage disposal, buildings, etc. 2500 w. Eng News—Dec. 29, 1904. No. 66945.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic Telephones.

Is the Automatic Telephone System Best for the Telephone Patron? P. Kerr Higgins. Read before the Engrs. & Archts. Assn., Los Angeles, Cal. Reviews briefly the features of both systems, and discusses the requirements of a successful automatic system. 2000 w. Elec, N Y—Dec. 7, 1904. Serial. 1st part. No. 66515.

Line Protection.

Commercial Aspects of Telephone Line Protection. Kempster B. Miller. Considers where and under what conditions protection should be given, and under what conditions it is better to take some risk and give only partial protection or none at all. 2500 w. Elec Rev, N Y—Dec. 10, 1904. No. 66590.

Selenium.

Selenium and Its Applications in Light Telephony (Ueber das Selen und Seine Bedeutung für die Elektrotechnik unter Besonderer Berücksichtigung der Lichttelephonie). Ernst Ruhmer. A long paper upon the application of selenium for converting light waves into electricity. 7000 w. Elektrotech Zeitschr—Dec. 1, 1904. No. 66864 B.

Signals.

The Use of Telegraph Lines for Signal Conductors (Telegraphenleitungen als Rückleitungen für Signalleitungen). A. Prasch. Describing experiments made on the Austrian railways without interfering with the use of the wires for telegraphy. 2500 w. Elektrotech Zeitschr—Dec. 8, 1904. No. 66866 B.

Space Telegraphy.

An Electrolytic Wireless Telegraph Detector. Dr. James E. Ives. An account of experimental investigations to determine the precise nature of the action of the electrolytic oscillation detector, described by Dr. Lee de Forest in a paper before the Int. Elec. Cong. at St. Louis. 3000 w. Elec Wld & Engr—Dec. 10, 1904. No. 66560.

A New Magnetic Wave Detector (Neuer Magnetischer Wellenempfanger). W. Peukert. Describing the application of a detector using the principle of the hysteresis of iron in a varying magnetic field to the reception of waves in space telegraphy. 1200 w. Elektrotech Zeitschr—Nov. 24, 1904. No. 66861 B.

Experiments on the Reception by Wires of Electric Waves. C. A. Chant. An account of experiments made in connection with the receiving antenna as used in the Braun, Siemens & Halske system of wireless telegraphy, the radiation from transmitters, the effect on resonance of inserting a coherer in an open wire, &c. 3000 w. Am Jour of Sci—Dec., 1904. No. 66649 D.

The Erection of a 180-Foot Mast for Wireless Telegraphy and Telephony. Joseph B. Baker. An account of the erection of a mast built of three wood spars, near Boston. Ills. 2400 w. Elec Wld & Engr—Dec. 24, 1904. No. 66799.

Telautograph.

The Telautograph. Illustrated description of the automatic reproducing telegraph constructed by the National Gray Telautograph Co., of New York, explaining its operation. 1000 w. Engng—Dec. 2, 1904. No. 66637 A.

Telegraph.

The Pollak-Virag Rapid Telegraph. An illustrated explanation of the working of this system. 1200 w. Engr, Lond—Dec. 16, 1904. No. 66927 A.

Telephone Lines.

A New Danger to Telephone Lines. J. C. Kelsey. Discusses troubles that may come with the use of the grounded alternating trolley system. 2500 w. Elec Rev, N. Y.—Dec. 17, 1904. No. 66709.

Telephony.

Fundamental Principles of Power Equipment for Telephone Exchanges. B. D. Willis. Discusses in detail the fundamental parts of telephone power plants. 2200 w. Elec Wld & Engr—Dec. 17, 1904. No. 66710.

The Chicago Telephone Company's "Juice Wagon." An illustrated description of the method of thawing out frozen laterals. 2000 w. Elec Wld & Engr—Dec. 10, 1904. No. 66562.

The Cost of Telephone Service in a Farming Community. H. Sprague. Gives figures drawn from American practice, in regard to the actual cost of operation. 2800 w. Elec Wld & Engr—Dec. 10, 1904. No. 66563.

The Principles of Exchange Telephony. Herbert Laws Webb. A discussion of some of the details of telephone service and the principles of operation. Considers the proper unit of the local service to be the message, and discusses signaling, economy, rates, &c. 6500 w. Cassier's Mag—Dec., 1904. No. 66458 B.

The Quality of Telephone Service. Samuel G. McMeen. Discusses the elements that contribute to making the service satisfactory. 2800 w. Elec Rev, N. Y.—Dec. 17, 1904. No. 66708.

Testing.

See Eectrical Engineering, Measurement.

DISTRIBUTION.

Buffalo.

Niagara Power in Buffalo. The first of a series of articles dealing with the distribution of electrical energy by the Cataract Power & Conduit Company, the cost, equipment, &c. 4400 w. Elec Wld & Engr—Dec. 3, 1904. Serial. 1st part. No. 66508.

Cables.

Tables for the Loading of Simple Continuous-Current Cables (Belastungstabelle für Einfache Gleichstromkabel). Dr. Huberth Kath. Tables giving the maximum current permissible in continuous-current cables, according to the committee of the *Verband Deutscher Elektrotechniker.* 6000 w. Elektrotech Zeitschr—Nov. 17, 1904. No. 66858 B.

The Prevention of Induction in Cables for Weak Currents (Ueber die Vermeidung der Induktion bei Schwachstromkabeln). J. Schmidt. A description of the various methods of manufacturing and insulating cables, with especial reference to minimising the effects of induction. 3500 w. Zeitschr f Elektrotechnik—Dec. 11, 1904. No. 66873 D.

The Warning of Polyphase Underground Cables (Die Erwärmung Unterirdisch Verlegter Drehstromkabel). Dr. Richard Apt and Carl Mauritius. With numerous diagrams showing data and results of experiments. 3500 w. Elektrotech Zeitschr—Dec. 1, 1904. No. 66862 B.

Insulators.

Porcelain Insulators: Their Manufacture and Testing. H. W. Crozier. Brief description of methods of manufacture and testing. 2300 w. Cal Jour of Tech—Oct., 1904. No. 66420 C.

The Evolution of High-Tension Insulators. Reviews the paper of V. G. Converse read before the International Electrical Congress. Also editorial. Shows the requirements which practice has shown to be necessary for the pressures now used, and gives illustrated descriptions of types, showing developments. 4200 w. Elec Wld & Engr—Dec. 3, 1904. No. 66511.

Regulations.

The Home Office Draft Regulations for the Use of Electricity in Factories and Workshops. Frank Broadbent. A critical review of the Home Office regulations and those of the Board of Trade, which are compared. 4000 w. Elec Rev, Lond —Dec. 9, 1904. No. 66728 A.

South Wales.

Electric Power Distribution in South Wales. Map and illustrated description of a system supplying power to a large number of collieries and other works in the South Wales industrial district. 4000 w. Elect'n, Lond—Dec. 2, 1904. Serial. 1st part. No. 66632 A.

Sub-Stations.

The Lay-Out and Construction of a Modern Sub-Station. S. O. Swenson. An illustrated description of the design of the Ohio Street sub-station of the Chicago Edison Co. 2800 w. Am Elect'n—Dec., 1904. No. 66496.

The Substation of the Helena Light and Traction Company. Illustrated detailed description of a new substation made necessary by a fire. 2000 w. Jour of Elec —Dec., 1904. No. 66586 C.

Testing.

See Electrical Engineering, Measurement.

Three-Wire.

The Operation of a Three-Wire System with Battery (Ueber die Speisung eines Dreileiternetzes mit einer Batteriehälfte). F. Hohenemser. A brief description of a method of connecting a storage battery to a three-wire distribution system. 800 w. Elektrotech Zeitschr—Dec. 15, 1904. No. 66868 B.

Transformers.

The Computation of Transformers (Zur Berechnung von Transformatoren). Dr. Richard Hiecke. Deducing formulas and tables for the most efficient proportions of transformers, with practical applications. 3000 w. Zeitschr f Elektrotechnik—Nov. 13, 1904. No. 66869 D.

ELECTRO-CHEMISTRY.

Alternating.

Notes on Electrolysis with Alternating Currents (Beiträge zu Unseren Kenntnissen über die Elektrolyse mit Wechselströmen). A. Brochet and A. Petit. A long paper upon the methods by which alternating currents may be used for electrolytic purposes. 6000 w. Zeitschr f Elektrochemie—Dec. 2, 1904. No. 66876 D.

Aluminum.

Resistance and Polarization of Aluminum Anodes (Uebergangswiderstand und Polarisation an der Aluminuin-anode). Franz Fischer. A discussion of the conditions for the successful electro-deposition of aluminum. 4500 w. Zeitschr f Elektrochemie—Nov. 11, 1904. No. 66874 D.

Cells.

The Dynelectron. S. D. V. Burr. An illustrated description of the dynelectron cell, invented by James H. Reid, and its action, for producing electricity direct from heat. 1800 w. Ir Age—Dec. 8, 1904. No. 66542.

Copper.

Rapid Copper Plating Without Agitation or Warming (Schnell Kupferplastik ohne Umrührung und Erwarmung). Sergius v. Maximowitsch. The electrodes are placed horizontally, with the cathode beneath, the sulphate of copper sinking by gravity. 1000 w. Elektrochem Zeitschr—Nov., 1904. No. 66877 G.

Electric Furnaces.

The Electric Furnace: Its Origin. Transformations and Applications. Adolphe Minet. Defines and explains the apparatus, reviewing its history, and giving a bibliography of efforts which have been made to develop industries centering round the electric furnace. Discussion. 9500 w. Elec-Chem & Met—Dec., 1904. No. 66658 C.

Electro-Metallurgy.

A French Electro-Metallurgical Works. A short illustrated description of the La Praz installation, with remarks on other works in France. 2300 w. Min Rept—Dec. 1, 1904. No. 66499.

Electric Furnace Methods in Iron and Steel Manufacture in Comparison with the Ordinary Metallurgical Processes. Prof. B. Neumann. A review of this subject, with the conclusion that only for making special steels and high-per cent. ferro-alloys can the electric furnace be used economically. 2500 w. Elec-Chem Ind—Dec., 1904. No. 66608 C.

Electric Furnace Processes for Iron and Steel Manufacture. A summary of the report of the Commission appointed by the Canadian Government to investigate the different electrothermic processes for the smelting of iron ore and the making of steel in operation in Europe, calling attention to points that are new. 9000 w. Elec-Chem Ind—Dec., 1904. No. 66607 C.

Report of the Canadian Commission on Electrothermic Processes for the Production of Iron. Review of the report of a commission appointed to investigate the different electrothermic processes for the smelting of iron ores and the making of different classes of steel. 2500 w. Elec Rev, N Y—Dec. 3, 1904. No. 66480.

The Production of Iron and Steel by Electric Processes (Die Herstellung von Eisen und Stahl auf Elektrischem Wege). Dr. Albert Neuburger. A very complete account of the practical applications thus far made of the electric furnace for smelting and refining iron and steel. Two articles. 8000 w. Glasers Annalen—Nov. 15, Dec. 1, 1904. No. 66826 each D.

The Production of Iron and Steel by the Electric Furnace. W. McClure. An illustrated article reviewing the various systems proposed, describing types of furnaces, and considering applications of the electrical system. 4300 w. Engng Rev—Dec., 1904. No. 66647 B.

Review.

Experimental Electrochemistry. N. Monroe Hopkins. This introduction to a series of papers gives a review of the historical work, with important classic researches and discoveries, and simple diagrams of the use of the electric current to electrolysis. Ills. 4400 w. Sci Am Sup—Dec. 3, 1904. Serial. 1st part. No. 66453.

Soda.

The Electrolytic Manufacture of Soda (Etude sur la Fabrication de la Soude Electrolytique). A description of the Heibling process, as conducted at Caudéran, near Bordeaux. 2000 w. L'Electrochimie—Nov., 1904. No. 66878 D.

ELECTRO-PHYSICS.

Air-Gaps.

The Magnetic Resistance of Air-Gaps. Translated from the *Electrotechnische Zeitschrift*. Results of experiments carried out by Dr. G. Benischke. 500 w. Elec Rev, Lond—Dec. 16, 1904. No. 66917 A.

Armatures.

Hydrodynamical and Electromagnetic Investigations Regarding the Magnetic-Flux Distribution in Toothed Armatures. Prof. H. S. Hele-Shaw, Alfred Hay, and P. H. Powell. Read before the Inst. of Elec Engrs. An illustrated account of investigations of air-gap reluctance, and reluctance of teeth in a slotted armature, with description of apparatus used, is given in the present number. 3500 w. Elec Engr, Lond—Nov. 25, 1904. Serial. 1st part. No. 66527 A.

On the Experimental Determination of the E. M. F. of Dispersion of Stray Field of an Armature Winding. C. F. Guilbert. Describes a method applying particularly to a revolving-field alternator, in which the armature is the external stator and the revolving field the internal rotor. 2500 w. Elec Wld & Engr—Dec. 3, 1904. No. 66510.

Dielectrics.

Experiments with Solid Dielectrics (Recherches sur les Diélectriques Solides). MM. V. Crémieu and L. Malclès. A discussion of experiments showing the existence of reactive charges in the interior of solid dielectrics. 1200 w. Comptes Rendus—Dec. 5, 1904. No. 66846 D.

The Dielectric Strength of Certain Specimens of Mica. Ernest Wilson and W. H. Wilson. Gives results of experiments, describing method of testing. 1000 w. Elect'n, Lond—Dec. 16, 1904. No. 66920 A.

Electric Sterilizer.

The Otto Electric Sterilizer. Translated from *La Nature*. Illustrates and describes an apparatus for the sterilization of water in private houses. 900 w. Sci Am Sup—Dec. 31, 1904. No. 66947.

Electromagnets.

The Predetermination of Plunger Electromagnets. Prof. Silvanus P. Thompson. Read before the Int. Elec. Cong. at St. Louis. A brief account of rules worked out by the author for the design of plunger electromagnets to fill required specifications. Ills. 5500 w. Elec Wld & Engr—Dec. 10, 1904. No. 66561.

Interrupter.

Electric Arc Interrupter (Lichtbogenunterbrecher). Dr. Hugo Mosler. Describing an arrangement of electric arcs in series for producing interruptions of high frequency for operating induction coils. 1200 w. Elektrotech Zeitschr—Dec. 1, 1904. No. 66863 B.

Magnets.

The Heating of Magnet Coils (Ueber Erwärmung von Magnetspulen). H. Lacroix. Deriving an approximate formula for computing the heating from the size and winding. 1800 w. Electrotech Zeitschr—Nov. 24, 1904. No. 66860 B.

Resistors.

Materials for Resistors. Francis A. J. Fitz Gerald. Explains the meaning of the term as used, and gives an experimental study, with conclusions. 5500 w. Elec-Chem Ind—Dec., 1904. No. 66609 C.

Striking Distance.

The Striking Distance in Gaseous Liquid and Solid Substances (Die Schlagweiten in Gasförmigen Flüssigen und Festen Korpern). Dr. W. Voege. Giving results of experiments showing the lengths of sparks at different voltages. 2500 w. Elektrotech Zeitschr—Dec. 8, 1904. No. 66865 B.

GENERATING STATIONS.

Alternator Regulation.

On the Theory of the Regulation of Alternators. C. F. Guilbert. Aims to show that a method suggested by the author two years ago leads in general, and especially in the case of an inductive load, to a much greater approximation than that demonstrated by Messrs. Hobart and Punga, presented before Am. Inst. of Elec Engrs. 3300 w. Elec Wld & Engr—Dec. 17, 1904. No. 66712.

Combination Plants.

The Combination of Dust Destructors and Electricity Works Economically Considered. W. P. Adams. Abstract of a paper read before the Inst. of Elec Engrs. Gives a brief description of generally known types of destructors, discussing the principal aspect of combined plants, and the commercial results achieved. 4400 w. Elect'n, Lond—Dec. 16, 1904. Serial. 1st part. No. 66919 A.

The Combined Lighting and Heating Plants of the Columbus, Ohio, Public Service Company. Illustrates and describes a recently installed plant for heating by means of hot water, as an auxiliary service from an electric generating plant. 2200 w. Elec Wld & Engr—Dec. 3, 1904. No. 66506

Commutation.

Commutation and Straying (Ueber Kommutation und Streuung). F. Niethammer. A discussion of the conditions for sparkless commutation in continuous-current dynamos, and of the more precise determination of the stray field of induction motors. 2000 w. Zeitschr f Elektrotechnik—Nov. 20, 1904. No. 66870 D.

The Commutator. Norman G. Meade. Suggestions for refilling commutators. Ills. 1200 w. Mach, N Y—Dec., 1904. No. 66606 C.

Dynamos.

Comparative Designs for a 10-Kw. Dynamo. J. W. Burleigh. A short illustrated description of several types given for comparison. 800 w. Elec Rev, Lond—Dec. 9, 1904. No. 66726 A.

Efficiency of Compound-Wound, Direct-Current Generators. V. D. Moody. Describes the tests essential for accurate calculation of the efficiency, taking an actual case for demonstration. 2000 w. Elec Wld & Engr—Dec. 24, 1904. No. 66901.

Straightening Out a Dynamo. L. H. Pike. An account of a peculiar case in which the author was called to straighten out a factory dynamo. 1000 w. Power—Dec., 1904. No. 66601 C.

Gas Power.

See Mechanical Engineering, Combustion Motors.

Hydro-Electric.

A Central Station in the Tyrol. A. Steens. Illustrates and describes a water-power electrical generating plant of unusual interest at Zwolfmalgreien. 2200 w. Cent Sta—Dec., 1904. No. 66585.

Electricity from Water Power. A. A. Campbell Swinton. Read before the British Assn. An interesting review of hydro-electric engineering, with remarks on various installations. 3500 w. Sci Am Sup—Dec. 3, 1904. No. 66452.

The Bournillon Hydro-Electric Station (Usine Hydro-Electrique du Bournillon). Ch. Dantin. Describing the plant by which 3,750 horse power is developed from the Bourne, a tributary of the Isère, near Grenoble. The regulating apparatus is especially described. 2500 w. Génie Civil—Nov. 26, 1904. No. 66802 D.

The Installations of the Compagnie Vaudoise (Les Installations de la Compagnie Vaudoise). C. H. Perrin. A very complete account of the hydraulic generation and electrical transmission of 7000 horse power from lakes Joux and Orbe, in the canton of Vaud, Switzerland. Serial. Part I. 4000 w. Bull Tech de la Suisse Romande—Sept. 25, 1904. No. 66854 D.

The La Goule Hydroelectric Plant at Noirmont, Switzerland. Illustrated description of an interesting power plant in the mountains of Switzerland. It furnishes power for a large number of small motors used by watch makers; also furnishes light and power for French territory. 2200 w. Elec Rev, N Y—Dec. 10, 1904. No. 66589.

The Niagara Hydro-Electric Plant (Die Wasserkraft-Elektrizitätswerke am Niagara). K. Meyer. Describing especially the electrical machinery of the second power house of the Niagara Falls Power Co. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 19, 1904. No. 66809 D.

The Reservoirs and Electric Service of Solingen (Barrages-Reservoirs et Services Electriques de la Ville de Solingen). A. Bidault des Chaumes. With illustrations of the dams, artificial reservoirs and hydro-electric station near Solingen, in Rhenish Prussia. 3000 w. 1 plate. Génie Civil—Dec. 3, 1904. No. 66803 D.

Isolated Plant.

The Engineering Plant at the New Savoy Hotel. Sydney F. Walker. An illustrated article describing in detail the boiler plant, electricity generating plant, lighting service, cold-storage and ice-making plant, ventilating and heating system, elevator system, etc. 3000 w. Engng Rev—Dec., 1904. No. 66646 B.

The Power Plant of the Oliver Building, Boston. Howard S. Knowlton. Brief description of an isolated plant for supplying heat, light and power. 1000 w. Eng Rec—Dec. 17, 1904. No. 66685.

Oil.

Oil for Transformers, Switches, etc. E. Kilburn Scott. On the treatment of oil for transformers, and its proper use. 700 w. Elec Rev, Lond—Dec. 2, 1904. No. 66631 A.

Operation.

Electrical Pointers. W. H. Wakeman. Points concerning the operation of generators and motors, with diagrams. 2000 w. Power—Dec., 1904. No. 66597 C.

Parallel Driving.

See Mechanical Engineering, Steam Engineering.

South Africa.

Pietermaritzburg (Natal) Electric Lighting and Tramways. Brief, illustrated description of the plant. All the cables are laid underground. Maps. 3000 w. Elec Rev, Lond—Dec. 9, 1904. No. 66727 A.

Storage Batteries.

Limitations to the Use of Storage Batteries—An English Engineer's Views. H. M. Hobart, in *Technics*. A discussion of the deterioration and cost of storage batteries, their efficiency, etc. 2400 w. Sci Am Sup—Dec. 24, 1904. No. 66902.

LIGHTING.

Bridge Lighting.

The Illumination of the Williamsburg Bridge, New York City. Illustrates and describes the manner in which the lighting work has been carried out. 1500 w. Elec Wld & Engr—Dec. 24, 1904. No. 66798.

Signal Lamps.

Electric Signal Lighting on the Lancashire and Yorkshire Railway. Illustrates and describes the method employed for fitting up their electric signal lamps. 1500 w. Elec Rev, Lond—Dec. 2, 1904. No. 66628 A.

MEASUREMENT.

Accumulators.

Testing Instruments for Accumulators. H. M. Wyatt. Considers hydrometers and voltmeters and the proper way of using them. 2200 w. Autocar—Dec. 17, 1904. No. 66913 A.

Alternate-Current Instruments.

The Use of Iron in Alternate-Current Instruments. Dr. W. E. Sumpner. Abridged address before the Inst. of Elec. Engrs., Birmingham. Considers the reasons for the unsatisfactory results obtained with instruments for alternate-current measurements and the reasons and future prospects. 4000 w. Elect'n. Lond—Nov. 25, 1904. Serial. 1st part. No. 66532 A.

Faults.

The Measurement of an Insulation Fault Between a Cable and the Earth (Mesure d'un Défaut d'Isolement entre un Cable et la Terre). J. Vinson. Brief description of method of locating a fault in a distribution system while under charge. 800 w. Revue Technique—Nov. 25, 1905. No. 66834 D.

Magnetic Testing.

A Method of Measuring Magnetomotive Forces. Rudolf Goldschmidt. Illustrated description of a method of measuring the "magnetic potential drop," which is easy to manipulate, and requires a minimum of special apparatus or fine adjustment. 1200 w. Elect'n, Lond—Nov. 25, 1904. No. 66531 A.

Studies in Magnetic Testing. G. F. C. Searle. Read before the Inst. of Elec. Engrs. (Abridged). Describes investigations made by the author on the effects of magnetic treatment. A critical examination of the use of the ballistic method in magnetic tests of transformer iron. 4000 w. Elect'n, Lond—Dec. 9, 1904. Serial. 1st part. No. 66729 A.

Meter.

Notice of Test and Approval by the Testing Office (Bekanntmachung über Prüfungen und Beglaubigungen durch die Elektrischen Prüfämter). A report of the Reichsanstalt upon the testing of the O'Kennan continuous-current meter. 1800 w. Elektrotech Zeitschr—Nov. 24, 1904. No. 66859 B.

Power Factor.

The Power Factor Indicator. Harry W. Richardson. Describes the theory of action of the power factor indicator, explaining its action by the aid of mathematics. 1600 w. Elec Wld & Engr—Dec. 29, 1904. No. 66900.

Testing.

Special Methods for Locating Faults on Electric Cables. Henry W. Fisher. Illustrates and describes methods more or less connected with the Murray & Varley "Loop Tests," and emphasizes the importance of determining accurately the resistance of subsidiary resistances in the circuit of a faulty cable under localization test. 1600 w. Elec Wld & Engr—Dec. 17, 1904. No. 66711.

The Testing Equipment of a Common Battery Central Office. A. Dallam O'Brien. Discusses the principal troubles that arise on substation lines, and the methods used by the wire chief to locate them and to arrange for their removal. Diagrams. 3200 w. Am Elect'n—Dec., 1904. No. 66497.

Torque.

Electromagnetic Torque. A. S. McAllister. Describes somewhat unusual conditions for obtaining torque. Diagrams. 700 w. Elec Wld & Engr—Dec. 3, 1904. No. 66509.

MOTORS.

Commutator Motors.

Alternating-Current Commutator Motors (Wechselstrom-Kommutatormotoren). Dr. F. Niethammer. A general discussion of recent single-phase motors.

2000 w. Zeitschr f Elektrotechnik—Dec. 4, 1904. No. 66872 D.

Commutation in Alternating-Current Motors at Starting. Marius Latour. Presents some precise considerations relating to the special conditions of commutation at starting. 1200 w. Elec Wld & Engr—Dec. 3, 1904. No. 66507.

Multiple-Voltage.

Multiple Voltage Control of Motors. Norman Gardner Meade. An illustrated description of the Bullock system, stating its advantages, and remarks on the installation of the plant. 1500 w. Power—Dec., 1904. No. 66595 C.

Rheostat.

A New Form of Liquid Rheostat for Starting Electric Motors. States the advantages and disadvantages of liquid rheostats and gives an illustrated description of a new type invented by Mr. Woolliscroft. 1000 w. Sci Am—Dec. 3, 1904. No. 66450.

Variable Speed.

Standardizing Variable Speed Motors. W. H. Powell. Read before the Nat. Machine Tool Bldrs. Assn. Shows how the output for a given size motor frame and armature core varies for the different systems of speed control, and also when operated at different amounts of speed variation. 900 w. Ir Trd Rev—Dec. 1, 1904. No. 66429.

TRANSMISSION.

Lightning.

Lightning Protection. J. V. E. Titus. Read before the Colorado Elec. Lgt., Power & Ry. Assn. Discusses points to be considered in installing lightning arresters. 1800 w. Elec Rev, N Y—Dec. 24, 1904. No. 66778.

Power Transmission.

The Maximum Distance to Which Power Can Be Economically Transmitted. Ralph D. Mershon. States the assumptions on which the reasoning is based, and discusses the cost of line conductors as limiting the distance. 5500 w. Trans Am Inst of Elec Engrs—Dec. 23, 1904. No. 66651 D.

Shawinigan Falls.

The Electric Power Development at Shawinigan Falls. A description, with illustrations of the plant for the longest electrical transmission line in operation in Canada, which delivers current over ninety miles. 3000 w. Can Elec News—Dec., 1904. No. 66717.

MISCELLANY.

Address.

Some Difficulties in Getting On. J. Swinburne. Address delivered to the students of the Inst. of Elec. Engrs. 6000 w. Elect'n, Lond—Nov. 18, 1904. No. 66617 A.

Exhibit.

The Novel Features of the Westinghouse Exhibit at the Louisiana Purchase Exposition. Edgar S. Downs. Reviews the striking features of the exhibits. 3500 w. Elec Rev, N. Y.—Dec. 24, 1904. No. 66779.

Fire Hazard.

The Electrical Fire Hazard. C. J. H. Woodbury. Abstract of an address before the Brooklyn Inst. of Arts & Sciences. A discussion of the underwriter's rules. 1500 w. Elec Rev, N. Y.—Dec. 10, 1904. No. 66591.

Law.

The Law Relating to the Escape of Electricity. W. Valentine Ball. Discusses briefly the principles that appear to have been adopted by the courts in both England and America. 4400 w. Elec Wld & Engr—Dec. 17, 1904. No. 66713.

INDUSTRIAL ECONOMY

British Trade.

The Systematic Promotion of British Trade. Ben H. Morgan. Discusses the relations of the state and trade, the control of shipping monopolies, consular service, &c., &c. Discussion. 8800 w. Jour Soc of Arts—Nov. 25, 1904. No. 66521 A.

Coal Production.

The Coal Production of the World (Die Steinkohlenvorräte der Erde). Oskar Simmersbach. A classified statement of the coal production of the various important producing countries of the world, showing the rate of increase. 5000 w. Stahl u Eisen—Dec. 1, 1904. No. 66887 D.

Exports.

Six Years of British and American Electrical Export Statistics. W. Pollard Digby. Gives the exports to certain trade zones, considering the tendencies exhibited. 2000 w. Elec Rev, Lond—Nov. 25, 1904. No. 66529 A.

Locomotive Trade.

The British and American Locomotive Export Trade. W. Pollard Digby. A study of American and English returns, showing that British locomotive builders hold a high repute. 3000 w. Engr, Lond—Dec. 16, 1904. No. 66924 A.

Patents.

The Patent Laws. Charles Denton Abel. Reviews the systems in the different countries, discussing their defects, and proposing remedies. Appendices and discussion. 14000 w. Jour Soc of Arts—Dec. 16, 1904. No. 66910 A.

Works Management.

Machine Shop Management. Oscar E. Perrigo. Deals with the management of a model machine shop in a general way. 2800 w. Ir Trd Rev—Dec. 1, 1904. No. 66430.

The Organization and Methods of a Modern Industrial Works. J. Wilmer Henszey. Describes the management of the Baldwin Locomotive Works, in Philadelphia, which employs about 15,500 men. 3700 w. Jour Fr Inst—Dec., 1904. No. 66669 D.

MARINE AND NAVAL ENGINEERING

Battleships.

H. M. First-Class Battleship Triumph. Engravings and description of the vessel and its equipment. 1200 w. Engr, Lond—Nov. 25, 1904. No. 66537 A.

The Battleship Deutschland. Describes this first ship of a new class, commenting on the improvements introduced. 2000 w. Engr, Lond—Nov. 25, 1904. No. 66538 A.

The Italian Battleship "Regina Margherita." Two-page plate with detailed description of this vessel and its equipment. 2200 w. Engng—Nov. 25, 1904. No. 66534 A.

The Latest British Battleship. Illustrated description of the first-class battleship Dominion. 1200 w. Naut Gaz—Dec. 15, 1904. No. 66673.

U. S. Battleship Ohio. Lieut. J. F. Babcock. Illustrated description of the vessel, with report of official trial performance. 10700 w. Jour Am Soc of Nav Engrs—Nov., 1904. No. 66754 H.

Breakdowns.

Microscopic Observations on Naval Accidents. Thomas Andrews. A report of the writer's researches into some of the microscopic examinations of fractured portions of marine machinery. Fully illustrated. 3300 w. Engng—Dec. 2, 1904. Serial. 1st part. No. 66634 A.

Cofferdam.

Proposed Cofferdam for Raising the Battleship "Maine." An illustrated explanation of the proposed method of raising this vessel and freeing Havana harbor of the obstruction. 2500 w. Eng News—Dec. 8, 1904. No. 66554.

Cranes.

The Hydraulic Crane System on the Steamer Barbarossa (Die Hydraulische Krananlage auf dem Dampfer Barbarossa des Norddeutschen Lloyds). W. Gentsch. With illustrations showing the pumps, accumulators and general arrangements. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1904. No. 66807 D.

Cruiser.

United States Armored Cruiser Colorado. E. H. Scribner. Illustrated description of vessel, with report of the official trial. 6000 w. Jour Am Soc of Nav Engrs—Nov., 1904. No. 66758 H.

Floating Dock.

A New Offshore Floating Dock. Illustrated description of a new dock for the port of Hamburg. 700 w. Sci Am Sup—Dec. 31, 1904. No. 66946.

Freeboard.

Freeboard. Gives details connected with its origin and subsequent official application in Great Britain as one of the means to prevent overloading. 4500 w. Marine Engng—Dec., 1904. No. 66549 C.

Freight Handling.

Handling of Freight in British Ports. An illustrated article on the immense amount of freight entering these ports and the modern facilities for dealing with it expeditiously. 3500 w. Marine Rev—Dec. 1, 1904. No. 66484.

Lifeboat.

Unsinkable Lifeboat. Illustrated description of the Englehardt unsinkable lifeboat. 800 w. U. S. Cons Repts—Nov., 1904. No. 66740 D.

Motor Boats.

High-Speed Motor Boats (Les Canots Automobiles à Grande Vitesse). A. Tellier fils. Details of speed trials of a number of boats propelled by petrol motors at speeds up to 40 kilometres per hour. 4000 w. 1 plate. Mem Soc Ing Civ de France—Oct., 1904. No. 66851 G.

Naval Conflicts.

Naval Aspects of the War in the Far East. Archibald S. Hurd. Discusses the methods adopted by Japan and Russia, and the lessons to be learned. 8500 w. Cassier's Mag—Dec., 1904. No. 66459 B.

Navy Yards.

The Character of the Power Plants in the U. S. Navy Yards. A review of the report of civilian engineers retained to make an examination of the plants. 2500 w. Eng Rec—Dec. 3, 1904. No. 66475.

River Boats.

Steam Navigation on Western Rivers. An illustrated article describing the early boats used on the Mississippi and other Western rivers. 2300 w. Naut Gaz—Dec. 1, 1904. No. 66483.

Speeds.

The Criterion of High Speeds of Ships (Criterium des Navires à Grandes Vitesses). Vice Admiral Fournier. Showing that the resistance of the water at increasingly high speeds tends to become proportional to the square of the speed. 1500 w. Comptes Rendus—Dec. 5, 1904. No. 66844 D.

The Influence of Depth of Water on the Speed of Torpedo Boats (Versuche zur Ermittlung des Einflusses der Wassertiefe auf die Geschwindigkeit der Torpedoboote). H. Paulus. A discussion of trials of torpedo boats in deep and shallow water, with curves showing the results. 5000 w. Zeitschr d Ver Deutscher Ing—Dec. 10, 1904. No. 66815 D.

Steamers.

Paddle Steamers (Raddampfer). W. Kaemmerer. A description of the hull and engines of the paddle steamers built at Kiel for use in connection with the service of the Anatolian railway. 1500 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1904. No. 66806 D.

The New Thames Passenger Steamers. An account of the steps taken to establish a passenger steamboat service on the Thames River, and an illustrated description of the recommended design, with information concerning cost. 1700 w. Engr, Lond—Dec. 2, 1904. No. 66640 A.

Structural Details.

Experiments on Some Structural Details. An illustrated account of deviations from normal arrangements, tested to destruction under the authority of Lloyd's, to determine the actual efficiencies of some of the proposals made to effect economies or to obtain more space. 1400 w. Engr, Lond—Nov. 25, 1904. No. 66539 A.

Torpedo Boats.

Contract Trial of Torpedo Boat No. 27, the Blakely. Description of vessel and its equipment, with report of trial. 4800 w. Jour Am Soc of Nav Engrs—Nov., 1904. No. 66756 H.

Torpedoes.

The Discovery and Removal of Contact Mines (De la Recherche et du Dragage des Torpilles Vigilantes). M. Dibos. An account of modern floating contact mines used for harbor defence in time of war, and the methods of dragging for their removal. 3500 w. Mem Soc Ing Civ de France—Oct., 1904. No. 66852 G.

Turbines.

Reports on Turbine Installations. Reports of the installations on the steam yachts Lorena and Tarantula, and steamer Turbinia. Ills. 6700 w. Jour Am Soc of Nav Engrs—Nov., 1904. No. 66757 H.

Warships.

A United States Warship on Trial. An account of the government speed trial of the Pennsylvania, by a witness, with general remarks. 2000 w. Sci Am—Dec. 3, 1904. No. 66448.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

Frayer-Miller Air-Cooled Car. Illustrated detailed description. 1200 w. Automobile—Dec. 24, 1904. No. 66791.

Automobile Battery.

The Schneider-Canet du Bogage Automobile Battery of Quick-Firing Howitzers. Illustrations, with brief description. 600 w. Engng—Nov. 25, 1904. No. 66533 A.

Carbureter.

New Form of Automatic Carbureter. Illustrates and describes an interesting new carbureter brought out by Grouvelle and Arquembourg. 1800 w. Automobile—Dec. 24, 1904. No. 66790.

The Claudel Kerosene Carbureter. Explains the designer's theory of the gasification of heavy oils, and its practical application to automobile motors. 2400 w. Automobile—Dec. 10, 1904. No. 66579.

Electric Truck.

An Electric Truck Test. W. S. Timmis. Reports a test made of three electric trucks, extending over a period of four months, comparing cost with horse-drawn trucks. 1500 w. Am Mach—Vol. 27, No. 51. No. 66744.

Exhibition.

Motor Cars in Paris. Survey of the progress in the motor-car industry, as judged by the exhibits at the Paris Show. 3000 w. Engr, Lond—Dec. 16, 1904. Serial. 1st part. No. 66926 A.

Paris Salon, 1904. Brief illustrated descriptions of some of the exhibits, and remarks on the interesting features of the exhibition. 3500 w. Auto Jour—Dec. 17, 1904. Serial. 1st part. No. 66912 A.

Hub-Motor.

Practical Test of Hub-Motor Truck. An illustrated account of a demonstration made by the Holson electric truck on a steep hill in New York, with description of the steering and wheel construction. 2200 w. Automobile — Dec. 17, 1904. No. 66697.

Itala.

The 24-H. P. Itala Car. Illustrated description of a new car embodying features conducing to silent and smooth running, and ready accessibility for adjustment. 700 w. Autocar—Dec. 3, 1904. No. 66621 A.

Light Cars.

The Progress of the Light Motor Car. From a paper by W. W. Beaumont, read before the Automobile Club. Discusses questions affecting the design and construction of motor cars and motors. 4000 w. Engr, Lond—Dec. 9, 1904. No. 66736 A.

Omnibus Service.

The Great Western Motor Omnibus Services. W. B. Paley. An account of this system as used by the British railroad named. 2500 w. R R Gaz—Vol. XXXVII, No. 28. No. 66768.

Rolls-Royce.

The "Rolls-Royce" Petrol Cars. An illustrated description of a new car of British construction, to be exhibited at the Paris Salon. 1000 w. Auto Jour—Dec. 3, 1904. Serial. 1st part. No. 66623 A.

Simplex.

Simplex 30-H. P. Touring Car. Illustrated detailed description of new cars built in design and construction like the 75-h. p. S & M. Simplex special racing machine. 1500 w. Automobile—Dec. 10, 1904. No. 66578.

Stanley Show.

The Stanley Show. Illustrates and describes the tricars and other vehicles exhibited. 2800 w. Auto Jour—Nov. 26, 1904. No. 66524 A.

Steam Car.

New Grout Steam Car. Illustrates and describes the latest model of Grout Brothers of Orange, Mass. 900 w. Automobile —Dec. 24, 1904. No. 66792.

Wheels.

Motor Car Wheels. E. W. Walford. Discusses briefly the merits and demerits of each type. Ills. 1200 w. Autocar—Dec. 10, 1904. No. 66721 A.

White.

The New 15-H. P. White Steam Car. Illustrated description of a new car, noting its improvements. 2000 w. Autocar—Dec. 3, 1904. No. 66622 A.

COMBUSTION MOTORS.

Alcohol.

Industrial Alcohol (Alcool Industriel). Octave Rochat. A study of the applications of alcohol as a source of energy in internal-combustion motors. Three articles. 7500 w. Bull Tech de la Suisse Romande—Sept. 25, Oct. 10, 25, 1904. No. 66855 each D.

Diesel.

Diesel Engine at Rothesay. Illustrations, with brief description of the engine at work at the power-station of the Rothesay Tramways. 1400 w. Tram & Ry Wld—Dec. 8, 1904. No. 66771 B.

Notes on the Diesel Motor (Mitteilungen über den Dieselmotor). Illustrating very fully the later improved form of Diesel motor as constructed by Sulzer Bros., of Winterthur, Switzerland. A thermal efficiency of 35 per cent. on the brake horse power is attained. 3000 w. Schweiz Bauzeitung—Nov. 26, 1904. No. 66847 B.

Gas Engines.

Gas Engines for Central Stations. Hugh Campbell. Read before the Leeds Local Sec. of the Inst. of Elec. Engrs. Describes some recent plants where gas engines have been installed, showing the great improvement in economy since the first installation, and giving information of value. 3500 w. Engng—Dec. 16, 1904. No. 66923 A.

Gas Engines in Power Plants. William T. Magruder. Read before the Mech., Elec., & Steam Engrs. at the Canton, O., meeting. Discusses the advantages of the use of gas engines in power plants, and why they are not more frequently used. 2500 w. Ir Trd Rev—Dec. 8, 1904. No. 66547.

Power Generation with Large Gas Engines (Betriebserfahrungen mit Grossgasmotoren). H. Strack. Discussing especially the use of gas power in iron works, with illustrations of large gas-blowing engines. 6000 w. 3 plates. Stahl u Eisen—Nov. 15, 1904. No. 66884 D.

Recent Developments in Gas Engines. An illustrated article referring particularly to the large German and other European designs. 2400 w. Ir & Steel Mag—Dec., 1904. No. 66660 D.

The Gas Engine in Iron and Steel Works. J. H. Hamilton. Read at meeting of the Staffordshire Iron and Steel Inst. Considers the advantages of the internal combustion engine, discussing its efficiency, economy, etc. 3700 w. Ir & Steel Trds Jour—Dec. 3, 1904. No. 66633 A.

The Regulation of Gas Engines. Dr. Charles E. Lucke. Concludes that regulation of angular velocity can be adjusted in gas engines to as small limits as in steam engines; also considers regulation of steam. General discussion. 8700 w. Pro N Y R R Club—Nov. 18, 1904. No. 66674.

Gas Power.

The Tunis Central Station and the Pierson Gasogene. Emile Guarini. Illustrates and describes a station representing the most advanced engineering methods that have been developed in Europe for the driving of dynamos by gas engines that are in turn operated from gas generators especially designed for the purpose. 2200 w. Jour of Elec—Dec., 1904. No. 06587 C.

Gas Producers.

A Study of the Gas Producer (Untersuchungen an Gaserzeugern). Karl Wendt. Data and results of a series of experiments upon producer gas for motive power, using a specially designed experimental producer. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 26, 1904. No. 66811 D.

Suction Gas Producers. B. A. Sinn. An illustrated description of this type of apparatus which does away with the gas-holder, explaining the principles involved and the operation and care necessary. 3400 w. Power—Dec., 1904. No. 66598 C.

Gas Turbines

An Experimental Gas Turbine. Dr. Alfred Gradenwitz. An illustrated description showing the principle of the hot-air turbine invented by Dr. F. Stolze. 1500 w. Mach, N Y—Dec., 1904. No. 66603 C.

The Coming of the Gas Turbine. E. Kilburn Scott. A discussion of the chances of the gas turbine as a prime mover, with brief reference to the recent paper by R. M. Neilson. 1200 w. Elec Rev, Lond—Nov. 25, 1904. No. 66528 A.

Heat Motor.

A New Type of Heat Motor (Sur un Nouveau Genre d'Appareils Thermiques). H. Royer. A mathematical investigation of the application of the jet principle to combustion motors for the production of fluid pressure for action upon a turbine or similar machine. Serial, Part I. 7500 w. Revue de Mécanique—Nov. 30, 1904. No. 66856 E + F.

Ignition.

Electric Ignition for Combustion Motors (Die Elektrische Zündung bei Explosionsmotoren). Josef Löwy. A discussion of the best method of producing and timing the igniting spark for internal-combustion motors. 3000 w. Zeitschr f Elektrotechnik—Nov. 27, 1904. No. 66871 D.

Ignition as Applied to Internal Combustion Engines. Sir Oliver Lodge. Abstract of a lecture delivered before the members of the Automobile & Cycle Engrs'. Inst. Discusses briefly the critical point of ignition and types of ignition. 1700 w. Autocar—Dec. 10, 1904. No. 66722 A.

Petrol Engine.

The Craig-Dörwald 12-Cylinder Petrol Engine. Illustrated description of an engine in which compactness is the chief object aimed at. 1000 w. Auto Jour—Dec. 3, 1904. No. 66624 A.

HEATING AND COOLING.

Public Buildings.

The Warming of Public Buildings by the Warm-Air System Considered from a Hygienic Point of View. H. H. Grundy. Read before the British Inst. of Heating & Ven. Engrs. Discusses the necessity of introducing an ample supply of fresh air, and shows how an apparatus can be installed to introduce air from the outside of the building, the arrangement, operation, etc. 4000 w. Dom Engng—Dec. 24, 1904. No. 66789.

Refrigeration.

Comparing Refrigerating Systems. Relative value of compression refrigerating machines operated with ammonia, carbon dioxide and sulphur dioxide and wet and dry air coolers. Paper by Richard Stetefeld, with synopsis of discussion. Diagrams. 8200 w. Ice & Refrig—Dec., 1904. No. 66505 C.

Condensed Steam for Ice Making. William W. Stickney. Observations on the proper care of distilled water supply and how to overcome some of the most serious difficulties met. 1800 w. Ice & Refrig—Dec., 1904. No. 66504 C.

HYDRAULICS.

Cranes.

See Marine and Naval Engineering.

Current Wheels.

Current Wheels: Their Use in Lifting Water for Irrigation. From Bulletin 146 of the U. S. Dept. of Agri. An illustrated article on the theory of power in current wheels, their efficiency, practical operations, etc., describing wheels in actual use. 2000 w. Sci Am Sup—Dec. 3, 1904. Serial. 1st part. No. 66456.

Holyoke.

The Water Power at Holyoke. Albert F. Sickman. An interesting review of the history of the water power developed, the various dams, and their troubles, cost, etc. 5000 w. Jour N Eng W-Wks Assn—Dec., 1904. No. 66747 F.

Hydro-Electric Stations.

See Electrical Engineering, Generating Stations.

Hydraulic Packings.

Notes on Hydraulic Packings and Stuffing-Box Design. Ulrich Peters. Describes several constructions of hydraulic cylinder and plunger packings and their practical applications, and gives hints for selecting and designing satisfactory packing for parts moving under hydraulic pressure. 1500 w. Ir Age—Dec. 15, 1904. No. 66661.

Pipes.

The Flexure of the Walls of Pipes of Large Diameter (Flexion des Parois dans les Tuyaux de Conduites de Grand Diametre). C. Birault. An exhaustive discussion of the deflections and distortions of large pipes for conveying water for hydraulic power. 10,000 w. 1 plate. Mem Soc Ing Civ de France—Oct., 1904. No. 66849 G.

Plumbing.

Sanitary Plumbing and the Plumbing Laws. J. Pickering Putnam. Read before the Boston Soc of Arts. An examination of the plumbing laws, with suggestions for amendments. Ills. 3800 w. Am Archt —Dec. 24, 1904. Serial. 1st part. No. 66788.

Pumping.

A Study of Pumping Machinery (Versuche an Wasserhaltungen). Prof. Baum and Dr. H. Hoffmann. A comparison of the performances of steam, hydraulic, and electrical mine pumping plants in actual service, with data and results of tests. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—Dec. 3, 1904. No. 66813 D.

Pumping Plant for the New South Dock, Cardiff. Illustrated description of a large plant. 1000 w. Engr, Lond—Dec. 9, 1904. No. 66734 A.

The Development of Power Pumping Machinery. W. M. Barr. Modern methods of overcoming high lifts and heavy service, with latest improved forms of pumping machinery. 2500 w. Engineering Magazine—Jan., 1905. No. 66895 B.

Pumps.

Pumps in Central Stations. W. T. Edwards. Suggestions for the care and management of these pumps; the power required, size, etc., are also considered. 1500 w. Am Elect'n—Dec., 1904. No. 66498.

Valves.

The Action of Pump Valves (Fonctionnement des Soupapes de Pompes). M. Lecuir. A translation of the paper of Berg upon experiments on spring-loaded pump valves. Serial. Part I. 7000 w. Revue de Mécanique—Nov. 30, 1904. No. 66857 E + F.

Water Power.

The Commercial Development of Water Power. Alton D. Adams. Discusses the successful development of water power from a financial point of view, illustrating by cases from actual practice. 3000 w. Cassier's Mag—Dec., 1904. No. 66461 B.

MACHINE WORKS AND FOUNDRIES.

Balancing.

Notes Upon Balancing High-Speed Machinery. Explains the "critical speed" of bodies rotating with high velocity, and other points connected with the subject of balancing. Ills. 1500 w. Mach, N Y—Dec., 1904. No. 66604 C.

Blowers.

Fan and Positive Pressure Blower Tests. W. H. M'Faddon. Read before the Pittsburg Found. Assn. Gives history of tests made and conclusions reached. 4300 w. Ir Age—Dec. 8, 1904. No. 66543.

Boring.

A Boring-Mill Job. An illustrated account of a specially fitted up boring and turning mill which enabled the time for finishing a gas-engine fly-wheel to be reduced from 2 hrs. 20 min. to 45 min., and the work was better done. 1000 w. Am Mach—Vol. 27, No. 49. No. 66545.

Castings.

Casting Spouts and Tuyere-Boxes. Hiram W. Hixon. Drawings and description of methods for casting spouts for copper blast-furnaces, and tuyere-boxes for copper converters, of converter copper. 400 w. Eng & Min Jour—Dec. 22, 1904. No. 66762.

Chain.

Weldless Chain (Nahtlose Ketten). O. Klatte. Describing processes for making weldless chain by rolling and forming machinery. Two articles. 4000 w. Stahl u Eisen—Nov. 15, Dec. 1, 1904. No. 66885 each D.

Core Sand.

The Use of Old Core Sand. Charles A Smith. An explanation of the writer's practice of using old core sand in new core mixtures. 800 w. Foundry—Dec., 1904. No. 66675.

Dust Collecting.

The Exhaust System of Dust Collecting as Applied to Grinding Machinery, Etc. Vernon I. Norbury Williams. An illustrated article presenting the merits of this system. 2000 w. Ir & Coal Trds Rev—Dec. 2, 1904. No. 66643 A.

Electric Driving.

Motor Driving of Machine Tools. Dexter S. Kimball. Discusses the advantages and disadvantages of group driving compared to individual application of the motor, and the speed range to be given by the motor and the method of obtaining the same. 2800 w. Sib Jour of Engng—Dec., 1904. No. 66657 C.

The Advantages of the Electric Drive. D. N. Dunlop. States the advantages claimed, discussing the economy and increase of production. Ills. 4000 w. Ir &

Coal Trds Rev—Dec. 16, 1904. No. 66930 A.

Factory.

The Edward R. Ladew Leather Belting Factory. Brief, illustrated description of this factory at Glen Cove, L. I., and the methods of manufacture. 1400 w. Am Mach—Vol. 27. No. 51. No. 66743.

Foundations.

Foundations and Foundation Drawings. A. D. Williams. Directions for preparing foundations for heavy machinery. 1200 w. Am Mach—Vol. 27, No. 51. No. 66746.

Foundry Fuels.

Coal and Coke for Foundry Use. Prof. Bradley Stoughton. Read before the N. Y. Found. Foremen's Assn. An explanation of the origin and manufacture of these fuels. 1200 w. Foundry—Dec., 1904. No. 66079.

Foundry.

System in the Foundry. P. R. Ramp. Suggestions for daily reports useful in the successful management of the foundry. 1800 w. Foundry—Dec., 1904. No. 66680.

Gauges.

Variation in Size of Work Due to Type of Gauge. George Schlesinger. A summary of experiments made in connection with a limit gauge system. Ills. 1000 w. Am Mach—Vol. 27, No. 48. No. 66413

Lathe.

The Latest Hendey-Norton Lathe. Illustrated description of a lathe designed with the object of increasing the producing capacity. 1200 w. Ir Age—Dec. 29, 1904. No. 66935.

The New Prentice 18-Inch Lathe. Illustrated description of a lathe designed especially for use with the new tool steels. 1800 w. Ir Age—Dec. 1, 1904. No. 66467.

Malleable Work.

Loss in Malleable Foundry. R. F. Flinterman. Read at the A. F. A. convention. Gives in detail the methods employed for determining the character of the loss due to the chemical changes of various kinds. 1200 w. Foundry—Dec., 1904. No. 66677.

Molding.

Molding and Core Making for a Long Steam Feed Cylinder. R. H. Palmer. Illustrated detailed description. 800 w. Am Mach—Vol. 27, No. 48. No. 66414.

Sweeping a Mold for a Split Fly-Wheel. R. H. Palmer. Illustrated detailed description of method. 1600 w. Am Mach—Vol. 27, No. 52. No. 66933.

New Works.

Messrs. Bruce Peebles & Co.'s New Works at East Pilton, Edinburgh. An illustrated detailed description of a plant for the manufacture of electrical machinery and its general arrangement. 4000 w. Elec Engr, Lond—Nov. 25, 1904. No. 66526 A.

Planers.

Modern Planers. Brief, illustrated descriptions of various types, with general remarks. 4500 w. Cassier's Mag—Dec., 1904. No. 66460 B.

Planing.

Planing Cycloidal Curves. Howard A. Coombs. Illustrates and describes machines for planing the cycloidal surfaces of the "revolvers" of blowers, rotary pumps, etc., which partake of some of the characteristics of both planers and gear cutters. 1200 w. Am Mach—Vol. 27, No. 52. No. 66934.

Power Plant.

Power Plant at the Works of the Power and Mining Machinery Co. Illustrated description of the power plant of manufacturing works near Milwaukee, Wis. 2000 w. Engr, U S A—Dec. 15, 1904. No. 66695 C.

Records.

Pattern Loan Records. R. W. MacDowell. Describes a simple system of pattern records. 1800 w. Foundry—Dec., 1904. No. 66676.

Reversing-Gear.

Coil Clutch Reversing-Gear for Rolling Mills. Illustrated description of a very large reversing-clutch supplied to a copper-rolling mill in France. 1000 w. Engng—Dec. 16, 1904. No. 66922 A.

Rusty Nuts.

Removing Rusty Nuts and Bolts. Walter J. May. Suggestions. 900 w. Prac Engr—Dec. 2, 1904. No. 66626 A.

Shops.

Plant of the Locomotive & Machine Company of Montreal. Brief description, with illustration and plans. 700 w. Am Engr & R R Jour—Dec., 1904. No. 66440 C.

Messrs. Everett, Edgcumbe, and Co.'s London Works and Some of Their Specialties. Brief, illustrated description of the works and of some of the electrical instruments made by them. 3500 w. Elec Engr, Lond—Dec. 16, 1904. No. 66915 A.

The Works of the Power and Mining Machinery Co. Illustrated description of shops at Cudahy, Wis., designed to embody all tools and arrangements tending to secure economy in manufacture of its special products. 4000 w. Eng Rec—Dec. 3, 1904. No. 66473.

Shop Transport.

Mechanical Transport in the Modern Machine Shop. F. A. Waldron. A discussion of the economies effected by the use of cranes, hoists, and other conveying devices for minimizing the non-productive labor of the machinist. 4000 w. Engineering Magazine—Jan., 1905. No. 66889 B.

Slag.

Slag in Castings. William Leary. Discusses the causes and remedies for slag in castings and for kishy and gassy iron. 1500 w. Foundry—Dec., 1904. No. 66681.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Invar and Its Applications. Ch. Ed. Guillaume. Describes results obtained by this curious alloy, giving an account of its discovery, the applications made, and information of interest. Ills. 5500 w. Nature—Dec. 8, 1904. No. 66716 A.

Aluminum.

Making Castings in Aluminum. Briefly considers points which need attention to insure successful work. 900 w. Sci Am Sup—Dec. 24, 1904. No. 66903.

Brass.

Successful Brassfounding. John F. Buchanan. Read at the A. F. A. convention. A brief review of the history of brassfounding, with suggestions for producing successful work. 4000 w. Foundry—Dec., 1904. No. 66678.

Refractory.

A Study of Refractory Materials (Etude sur les Matériaux Réfractaires). M. A. Morel. An examination of the properties of materials employed to resist high temperatures, including graphite, silica, alumina, lime and the various fire clays. 4000 w. Revue Technique—Nov. 25, 1904. No. 66835 D.

Steel.

Heat Treatment Experiments with Chrome-Vanadium Steel. H. Riall Sankey and J. Kent Smith. An account of tests made to determine the effect of the addition of vanadium in varying proportions to pure carbon steels and to steels containing small percentages of chromium and nickel. Describes apparatus used and methods of making the tests, comparing results. Ills. 8400 w. Inst of Mech Engrs —Dec. 16, 1904. No. 66904 D.

Testing.

Modes of Testing Castings. W. T. MacCall. Abstract of a paper read before the British Found. Assn. Describes briefly the various tests applied to cast iron, and to some other metals. 2000 w. Ir & Coal Trds Rev—Dec. 9, 1904. No. 66739 A.

The Testing of Metals by the Flexion of Notched Bars (Sur l'Essai des Métaux par Flexion de Barreaux Entaillés). G. Charpy. Describing the use of a special form of ballistic pendulum for producing impact tests upon small notched bars of metal. 5000 w. Mem Soc Ing Civ de France—Oct., 1904. No. 66850 G.

Tool Steels.

Profit in the Use of High-Speed Steel Tools. A discussion of this subject, illustrating by a typical example. 2000 w. Ir Age—Dec. 1, 1904. No. 66466.

MEASUREMENT.

Mechanical Science.

Some Refinements of Mechanical Science. Ambrose Swasey. Presidential address on the methods and mechanisms which have been developed and perfected to a high degree of precision, such as clocks, sextants, and other instruments for measurement. 5000 w. Trans Am Soc of Mech Engrs, No. 058—Dec., 1904. No. 66512.

Metric System.

The Inch Versus the Meter for a Universal Metric System. George Moores. Discusses this subject, favoring the inch as the universal measure. 2400 w. Cassier's Mag—Dec., 1904. No. 66462 B.

Standards.

Volumetric Standards for Technical Work. W. J. Sharwood. Showing how limited is the number of fundamental substances which are actually required to standardize the more important solutions in ordinary use. 1200 w. Cal Jour of Tech —Oct., 1904. No. 66418 C.

Tanks.

Calculating Diagrams for Capacities of Tanks, Etc. E. C. de Wolfe. Gives diagram for estimating approximately the capacity of tanks, cisterns, or other vessels, or for finding the quantity of their contents when partially filled. 2700 w. Power —Dec., 1904. No. 66596 C.

POWER AND TRANSMISSION.

Air.

The Mechanical Transport of Air. W. B. Snow. A fully illustrated account of the manner in which the fundamental problems of ventilation and draft have been solved. 3000 w. Engineering Magazine—Jan., 1905. No. 66891 B.

Air Compressors.

Air Compressors and Their Valve Gear. Charles Hurst. An illustrated article comparing the merits of automatic and positive valve-compressors. 2500 w. Engng Rev—Dec., 1904. No. 66719 B.

Air-Compressor Tests (Versuche an Luftkompressoren). Data and results of two air compressors in actual service. 2000 w. Glückauf—Nov. 12, 1904. No. 66880 B.

Cone Pulleys.

A Diagram for Cone Pulley and Back

Gear Problems. Gives diagram, with directions for use. 500 w. Am. Mach—Vol. 27, No. 49. No. 66544.

Conveyors.

Electrically Driven Conveyors (Elektrisch Betriebene Schwebetransporte). G. Dieterich. Illustrating and describing a variety of overhead devices carrying electric trolleys for conveying material. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 19, 1904. No. 66805 each D.

The Use of Electricity in Driving Coal Conveying Machinery. Frank C. Perkins. An illustrated description of apparatus at the works of a large steel company at Sparrow's Pt., Md. 700 w. Sci Am—Dec. 10, 1904. No. 66558.

Cranes.

The Shaw Electric Crane at the World's Fair. Illustrated description, with details of special features of the crane awarded the grand prize in Group 64. 800 w. Ir Age—Dec. 1, 1904. No. 66463.

Elevators.

The Aero-Hydraulic Elevator. William Baxter, Jr. Illustrated description of a system in which the water pressure required to operate the car is obtained by means of compressed air or steam. 1600 w. Engr, U S A—Dec. 15, 1904. No. 66696 C.

Handling.

Labor Saving in the Handling of Materials. A. J. S. B. Little. A fully illustrated description of the increasing use of conveying machinery in general manufacturing plants. 4000 w. Engineering Magazine—Jan., 1905. No. 66893 B.

Modern Coal and Ore Handling Machinery. Henry S. Fleming. Illustrates and describes a few modern systems for the mechanical handling of materials. 2000 w. Min Mag—Dec., 1904. No. 66519 C.

Heat Motor.

The Athermic Motor (Moteur Athermique). Leo Dex. A description of a machine operating by the utilization of extremely low temperatures, employing liquid carbonic acid. Serial. Part I. 7000 w. Revue Technique—Dec. 10, 1904. No. 66836 D.

Prime Movers.

Notes on Power Production. William McClellan. Discusses the reliability and cost of steam engines, steam turbines and gas engines, and the outlook. 5400 w. Eng News—Dec. 29, 1904. No. 66942.

Ropes.

Rope Driving. A consideration of points conducive to successful rope-driving. 1500 w. Col. Guard—Dec. 9, 1904. No. 66730 A.

The Transmission of Power by Ropes. Edwin Kenyon. A discussion of conditions where the transmission of power by ropes is more economical, and the applications that may be made of this method of driving, the different systems, and all details connected with them. Ills. 11700 w. Trans Inst of Engrs & Shipbuilders—Nov. 22, 1904. No. 66909 D.

Safety Appliances.

Recent Safety Appliances for Cotton Mules. J. H. Crabtree. Illustrated descriptions of scroll and pulley-guards for the prevention of accidents. 1800 w. Engng Dec. 2, 1904. No. 66635 A.

Wind Motor.

The Conical Wind Motor. Dr. Alfred Gradenwitz. Gives some results of experiments made by Prof. La Cour for the Danish Government. Ills. 800 w. Elec Rev, Lond—Dec. 16, 1904. No. 66916 A.

STEAM ENGINEERING.

Bearings.

Engine-Shaft Bearings. William Turner. Abstract of a paper read before the Manchester Assn. of Engrs. A criticism of views advanced in a paper by "A Naval Engineer," with discussion of the proper adjustment of bearings, and related subjects. 2500 w. Mech Engr—Dec. 3, 1904. Serial. 1st part. No. 66627 A.

The Determination of the Length of a Crank Shaft Bearing (Die Bestimmung der Länge eines Kurbellagers). Prof. O. Grove. An examination of the distribution of pressures upon the main bearing adjacent to an engine crank. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 19, 1904. No. 66810 D.

Boilers.

A Comparison of Vertical and Horizontal Tubes in Water-Tube Boilers. W. R. Cummins. Abstract of a paper read before the North-East Coast Inst. of Engrs. Written to raise a discussion on the relative merits of vertical and horizontal tubes in water-tube boilers. Ills. 4000 w. Ir & Coal Trds Rev—Dec. 2, 1904. No. 66642 A.

Latest Type of Babcock & Wilcox Marine Boiler. R. K. Crank. Illustrates and describes details of the design and construction. 6500 w. Jour Am Soc of Nav Engrs—Nov., 1904. No. 66759 H.

Test of a Niclausse Boiler Under Forced Draft. W. M. Parks. A report of tests made to determine whether the proportions of the boiler were such that it could be forced to a high rate of coal combustion without injury. Ills. 3500 w. Jour Am Soc of Nav Engrs—Nov., 1904. No. 66755 H.

Boiler Tests.

Notes on Boiler Tests. J. E. Bell. Read before the Ohio Soc. of Mech., Elec., and

Steam Engrs. Suggestions for making a complete boiler test in the right way, with remarks on tests made. 3500 w. Engr, U S A—Dec. 1, 1904. No. 66427 C.

Chimney.

See Civil Engineering and Construction.

Combustion.

The Relation of the Volume of Hot Gases to the Heat Generated (Abhängigkeit des Ranchgasvolumens von der Erzeugten Wärmemenge und ihre Anwendung). A. Dosch. An examination of the conditions of combustion in boiler furnaces, with especial reference to the influence of the volume of gases to the transfer of heat. Two articles. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 18, 25, 1904. No. 66819 each D.

Economy.

The Best Economy of the Piston Steam Engine at the Advent of the Steam Turbine. J. E. Denton. Read before the Int. Cong. of Arts and Sciences at St. Louis. Reviews the development of steam-engine economy in engines of various types, showing that the turbine is already a formidable competitor. 5000 w. Eng News—Dec. 8, 1904. No. 66553.

Engine Tests.

Interesting Results of the Tests of a Reeves Simple Engine. Prof. R. C. Carpenter, assisted by Prof. H. Diederichs. Describes tests made at Sibley College. 1200 w. Wis Engr—Dec., 1904. No. 66906 D.

Exhaust Steam.

The Utilization of Exhaust Steam (L'Utilisation des Vapeurs d'Echappement). P. Chaleil. A review of the Rateau steam accumulator, and its application to the regulation of exhaust steam for use in the low-pressure steam turbine. 3500 w. Rev Gen d Sciences—Nov. 30, 1904. No. 66853 D.

The Utilization of the Exhaust Steam of Intermittent Motors (Abdampf-Verwertung Intermittierender Maschinen in Berg und Hüttenwerken). W. Küppers. With especial reference to the use of the Rateau steam accumulator for equalizing exhaust steam pressures for use with the low-pressure steam turbine. 1800 w. Glasers Annalen—Nov. 15, 1904. No. 66827 D.

Explosions.

Boiler Explosions (Sur les Explosions de Chaudières). L. Le Cornu. A discussion of the dynamic effects due to the sudden liberation of highly heated water in a boiler explosion; with especial reference to the explosion of a locomotive at the Gare St. Lazare, July 4, 1904. 1200 w. Comptes Rendus — Nov. 7, 1904. No. 66840 D.

Feed-Water.

Boiler Feed Waters and Scale. A. M. Wickens. Read before the Can. Soc. of Chem. Ind. Suggestions on the care of boilers and improvement of feed waters. 2400 w. Can Engr—Dec., 1904. No. 66588.

Purifying Boiler Feed-Water. R. T. Strohm. Discusses the various methods in use, illustrating a live steam purifier and describing its advantages. Considers an analysis of the water to be treated necessary and a system adopted to meet each case. 2500 w. Am Elect'n—Dec., 1904. No. 66494.

Qualitative Testing of Feed Water. William H. Jenkins. Gives methods by which any engineer can determine the character of the impurities in the feed water he is using. Ills. 2400 w. Power—Dec., 1904. No. 66602 C.

Water Softening. A. H. Jackson. Presidential address to the Incor. Inst. of Analysts, Assayers, and Metallurgists. Remarks on the advantages of treating water before entering the boiler, with review of the Archbutt-Deely process, are given in the present number. Ills. 3400 w. Aust Min Stand—Nov. 10, 1904. Serial. 1st part. No. 66724 B.

Fire Engines.

The Modern Steam Fire Engine. F. F. Loomis. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. A review of the history of steam fire engines, and a discussion of the requisites for a modern steam fire engine. 2000 w. Engr, U S A—Dec. 1, 1904. No. 66428 C.

Fly-Wheels.

The Design of Fly-Wheels. A. H. Gibson. Considers the design and construction, showing the conditions which they must fulfil under certain circumstances, and the suitability of various designs for fulfilling these conditions. Ills. 3500 w. Engng Rev—Dec., 1904. Serial. 1st part No. 66718 B.

Fuel Economy.

Boiler Fuel Economy in a Water-Gas Works. J. A. Perry. Considers in detail the steps necessary to insure the best economy and indicates where certain mistakes in installation should be avoided. 4400 w. Pro Age—Dec. 15, 1904. Serial. 1st part. No. 66645.

Inspection.

The Inspection of a High-Speed Engine after Overhauling. Describes a method of examination recommended before running up an engine after it has left the fitters' hands. 2000 w. Elec Rev, Lond—Dec. 2, 1904. No. 66630 A.

Lubrication.

Lubricating the Valves and Cylinder. J.

W. Parker. Shows that to effectually lubricate the valves and pistons of a steam engine the oil must be applied on the upper sides of the parts to be lubricated. Ills. 1000 w. Power—Dec., 1904. No. 66599 C.

Oil Burners.

Steam vs. Air for Liquid Fuel and Oil Burners. From a paper by George G. Bennett. read before the Ohio Soc. of Mech., Elec., and Steam Engrs. On the advantages of oil as fuel, and the best ways of burning it. 2300 w. Am Mach—Vol. 27, No. 51. No. 66745.

Power Plants.

Power Plants of the Atlas Portland Cement Co. An illustrated detailed description of the power equipment of the Northampton, Pa., mills of this company. 6000 w. Power—Dec., 1904. No. 66594 C.

Rotary Engine.

The Hoffman Rotary Engine. An illustrated description of what is said to be the first rotary engine which has reached the stage of commercial manufacture. 2000 w. Ir Age—Dec. 29, 1904. No. 66936.

Smoke.

Discussion of F. J. Rowan's Paper on "The Smoke Problem." 6000 w. Trans Inst of Engrs & Shipbuilders—Nov. 22, 1904. No. 66908 D.

Speed Variations.

Steam Engines for the Parallel Driving of Alternators (Die Dampfmaschinen für den Antrieb Parallel Arbeitender Wechselstromgeneratoren). H. Holtze. An examination of the periodical speed variations of various combinations of reciprocating engines in connection with their influence upon the action of parallel-connected alternators. 6000 w. Elektrotech Zeitschr—Dec. 15, 1904. No. 66867 B.

Steam Engines.

Heavy Duty Engines in Steel Plants. Arthur L. Strickland. Read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Briefly describes the exterior process of manufacturing Bessemer steel, and the heavy duty engine service, explaining the kinds of engines used and the work expected of them. 1500 w. Ir Trd Rev—Dec. 1, 1904. No. 66431.

Piston-Valve Engine at the Mulhouse Electric Station (Machines à Vapeur à Pistons-Valves de la Nouvelle Centrale d'Electricité de Mulhouse). Fr. Lamey. Describing a cross-compound engine of which each cylinder is provided with four independently operated piston valves. 1800 w. 1 plate. Génie Civil—Nov. 19, 1904. No. 66801 D.

Some Large Engines in the Power Plant of the St. Louis Exhibition. An illustrated article dealing with details of the Reynolds-Corliss, Hamilton-Corliss, Willans, and Greenwald Four-Valve Engines. 2500 w. Eng News—Dec. 8, 1904. No. 66552.

Steam Engine with Piston Valves (Dampfmaschinen mit Kolbenschiebersteuerung). F. Lamey. Illustrated description of tandem compound condensing engine of 1000 h. p., with piston valves and Frikart valve gear, exhibited at St. Louis by the Elsass Machine Works, of Mulhouse. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Dec. 10, 1904. No. 66814 D.

The Scottdale Corliss Engine. Illustrated description of a new design having several novel features. 2000 w. Ir Age—Dec. 8, 1904. No. 66540.

Steam Piping.

High and Low-Pressure Steam Piping of the New York Subway Power House. Franz Koester. An illustrated detailed description of the pipe lines for distributing steam through this plant. 1800 w. Engr, U S A—Dec. 1, 1904. No. 66426 C.

Steam Turbines.

The Future of the Steam Turbine. Editorial on the future of the turbine in various ships, referring only to the Parsons system. 2400 w. Engng—Nov. 25, 1904. No. 66535 A.

The Steam Turbines of the St. Louis Exposition. Illustrated description of the Curtis steam turbine, and the Westinghouse-Parsons turbine. 2500 w. Power—Dec., 1904. No. 66600 C.

The Steam Turbine in a Refuse Destruction Plant. Dr. Alfred Gradenwitz. Describes the plant at Zurich, Switzerland. 1000 w. Munic Engng—Dec., 1904. No. 66652 C.

See also Marine and Naval Engineering.

Stoker.

The Jones Underfeed Stoker. Report of the Franklin Institute, through its Committee on Science and the Arts, on the invention of Evan William Jones, giving illustrated detailed description of the apparatus. 5000 w. Jour Fr Inst—Dec., 1904. No. 66670 D.

MISCELLANY.

Aeronautics.

A New Method of Constructing Aerial Screw Propellers (Sur un Nouveau Mode de Construction des Helices Aériennes). Ch. Renard. Describing a form of braced propeller of light weight and great stiffness; adapted for flying machines. 1500 w. Comptes Rendus—Nov. 7, 1904. No. 66839 D.

Experiments with the Airship "Mediterranean II." F. Payrey. Translated from *La Vie Automobile.* An account of experiments made, with the results. 1200 w. Sci Am Sup—Dec. 3, 1904. No. 66455.

Exhibition.

The International Exhibition at St. Louis, U. S. A. Walter Francis Reid. A brief account of the buildings and their contents, with remarks. Discussion. 9000 w. Jour Soc of Arts—Dec. 9, 1904. No. 66714 A.

Invention.

Studies in Invention. Leicester Allen. Introduction to a series of problems of educational value, calling for solutions and stating requirements. The first problem is also given. 1200 w. Am. Mach.—Vol. 27. No. 48. Serial. 1st. part. No. 66415.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Fatal Accidents in Coal Mining in 1903. Frederick L. Hoffman. A careful study of coal mine accidents in the United States. 1600 w. Eng & Min Jour—Dec. 22, 1904. No. 66760.

Alberta.

Geological Sketch of the Bankhead Coal Field. J. M. Turnbull. An illustrated article describing an unusual formation, and giving brief account of development, and other information. 2700 w. Can Min Rev—Nov. 30, 1904. No. 66482 B.

Coal Production.

See Industrial Economy.

Coal-Screening.

Coal-screening Plant. Illustrates and describes the plant at the Thryburgh Colliery, Kilnhurst. 2000 w. Engr, Lond—Dec. 2, 1904. No. 66641 A.

Coal Washing.

Coal Washing in Alabama. Erskine Ramsay and Charles E. Bowron. Reports an increase in the use of the process, illustrating and describing plants using Stewart washers and Robinson-Ramsay washers. 3500 w. Mines & Min—Dec., 1904. No. 66568 C.

Coal Washing in Great Britain. James Tonge. A description of the various methods employed and the different types of jiggers, trough washers, and wasting tables, giving costs. Ills. 5800 w. Mines & Min—Dec., 1904. No. 66565 C.

Tercio and Cuatro Mines. R. M. Hosea. An illustrated description of the coal washing and coking plants of the Colorado Fuel & Iron Co. 5500 w. Mines & Min—Dec., 1904. No. 66566 C.

Peat.

Bog Fuel. Edward Atkinson. An interesting account of the writer's experimental investigations and the results, with brief discussion. 4500 w. Jour N Eng W-Wks Assn—Dec., 1904. No. 66752 F.

Small Coal.

Small Size Anthracite. Samuel Sanford. Information in regard to the rapid increase in the consumption of the small sizes, and the amounts recently recovered by the washeries. 2200 w. Eng & Min Jour—Dec. 22, 1904. Serial. 1st part. No. 66761.

COPPER.

Boundary District.

The Granby Copper Mine. Dwight E. Woodbridge. An illustrated account of the location anl special features, methods of mining, the smelter, &c. 2500 w. Ir Age—Dec. 1, 1904. No. 66464.

British Columbia.

Britannia Mines, Howe Sound, B. C. William M. Brewer. An account of the development of mines near Vancouver, carrying high values in copper. 4500 w. Min & Sci Pr—Dec. 17, 1904. No. 66796.

Mining in the "Similkameen" Yale District, British Columbia. Frank Bailey. An illustrated account of this district, its natural beauty and wonderful resources. Rich copper deposits, mineral and coal fields, gold, platinum, &c., but copper predominates. 2400 w. Min Rept—Dec. 22, 1904. No. 66793.

Concentration.

The Washoe Reduction Works. An illustrated description of the concentrator at the plant of the Anaconda Copper Mining Co. at Anaconda, Montana. 1800 w. Mines & Min—Dec., 1904. No. 66573 C.

Determination.

A Modification of the Iodide Method for the Determination of Copper. J. H. Burfeind. Gives a general description of the method suitable for all ores and furnace materials under all conditions. 1600 w. Min Rept—Dec. 15, 1904. No. 66703.

Electro-Deposition.

See Electrical Engineering, Electrochemistry.

Hot Blast.

Hot Blast Generation. Herbert Haas. On the use of the hot-blast stove in copper smelting, with critical discussion of various types, and illustrated description of the design by the author. 2500 w. Eng & Min Jour—Dec. 29, 1904. No. 66949.

Low Grade Ores.

Notes on the Cyanide Method on Low Grade Copper Ores. James W. Howson. Describes the method as used by the author. 900 w. Cal Jour of Tech—Oct., 1904. No. 66421 C.

Manufacturing.

Martin's Improved Method of Manufacturing Copper by Direct Rolling with the Initial Refinery Heat. H. J. Martin. A description of this process with detailed plan of plant. 2000 w. Ir & Coal Trds Rev—Dec. 9, 1904. No. 66737 A.

Ores.

How Copper is Produced. Ralston Bell. Briefly describes the minerals which are important as sources of copper and considers the occurrence and treatment of the principal ores. 1800 w. Min Rept—Dec. 14, 1904. Serial. 1st part. No. 66701.

GOLD AND SILVER.

Amalgamation.

The Testing of Gold Ores by Amalgamation. Ernest A. Hersam. Describes methods of laboratory-amalgamation, discussing the effect of the size of the test-portion. 4500 w. Min Wld—Dec. 10, 1904. Serial. 1st part. No. 66584.

Assaying.

Determination of Silver in Ores in the Wet Way. F. Altneder. Describes an assay method for prospectors which dispenses with the heavy assay outfit and necessary accessories and with the expensive and delicate assay balances. 1200 w. Min & Sci Pr—Nov. 26, 1904. No. 66500.

California.

The Gold Mines of Angels, Cal. An illustrated article giving information of one of the oldest and most noted mining districts of California. 1200 w. Min & Sci Pr—Nov. 26, 1904. No. 66501.

Concentration.

Wet Concentration. Frederic Wooster Sherman. Describes methods by which minerals susceptible to this process can be recovered to a high percentage. Ills. 2800 w. Mines & Min—Dec., 1904. No. 66570 C.

Cripple Creek.

Current Practice at Cripple Creek. G. E. Wolcott. Describes the methods in use and the difficulties of concentration, ore-sorting, washing, &c. 2000 w. Eng & Min Jour—Dec. 8, 1904. No. 66551.

Crushing.

Fine Crushing of Banket Ore. W. A. Caldecott. Abstract of a paper read before the Inst. of Min. & Met., London. On the results of recent practice in the Rand. 1000 w. Eng & Min Jour—Dec. 15, 1904. No. 66692.

Some Comparisons Between Dry Crushing and Wet Crushing in Cyanide Solution. John T. Millikin. Abstracted from a paper on the practice of the dry crushing Imperial mill in the Black Hills. Comparisons with the fine wet crushing plants, discussing some features of dry crushing. 2000 w. Min Rept—Dec. 22, 1904. No. 66794.

Dredging.

Gold Dredging at Oroville. Howard D. Smith and Elwyn W. Stebbins. Describes the character of the ground, which is peculiarly favorable to dredge operations, and the types of dredges and methods used. Also gives a summary of the operating expenses. 4400 w. Eng & Min Jour—Dec. 8, 1904. No. 66550.

India.

Gold in British India. J. Malcolm Maclaren. Information concerning the Chota Nagpur field. 2500 w. Aust Min Stand—Nov. 10, 1904. No. 66723 B.

Nevada.

The New Gold Camps of Southern Nevada. An illustrated description of the mines of the Goldfield district. 5000 w. Min & Sci Pr—Nov. 26, 1904. No. 66502.

Ore Treatment.

A New Process for Treating Silver Sulphide and Gold Ore. M. Vaygouny. An account of experimental investigations with a solution of ferric chloride, common salt and hydrochloric or sulphuric acid. 2500 w. Eng & Min Jour—Dec. 29, 1904. No. 66951.

The New Chlorination. William E. Greenawalt. A comparison of chlorination and cyanidation, reporting tests made, and giving interesting information of recent development. Ills. 2200 w. Eng & Min Jour—Dec. 1, 1904. No. 66435.

Refining.

Lead and Silver Refining at the Canadian Smelting Works, Trail, B. C. E. Jacobs. A brief description of the general plant and operations of the smelter, with illustrated detailed description of the electrolytic lead refinery. 3300 w. B C Min Rec—Dec., 1904. No. 66546 B.

Re-grinding.

Re-grinding at El Oro. Charles Butters and E. M. Hamilton. Abstract of a paper read before the Inst. of Min. & Met., London. An account of the latest practice and the results. Also notes from the discussion of the paper. 2500 w. Eng & Min Jour—Dec. 15, 1904. No. 66690.

Separation.

The Separation of Sands from Slimes in the Cyanide Process. Charles H. Fulton. Describes the systems used in the Homestake and Hidden Fortune mills. 2800 w. Mines & Min—Dec., 1904. No. 66571 C.

Yukon.

Auriferous Bench Diggings of Bonanza, Yukon Territory. Describes the locality, with remarks on the probable source of the gold. 1000 w. Min & Sci Pr—Dec. 3, 1904. No. 66593.

IRON AND STEEL.

Blowing Engines.

The Loss of Pressure in Blowing-Engine Valves (Druckverluste in Gebläseventilen). Prof. L. Klein. Describing experiments upon the relation of lift to pressure loss in air valves of blowing engines operated at high speeds. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1904. No. 66808 D.

Cementation.

The Surface Hardening of Steel. Illustrated description of the manner in which the operation of cementation is effected, as given in a paper by Léon Guillet. 2000 w. Ir & Coal Trds Rev—Dec. 9, 1904. No. 66738 A.

Charging.

A New Blast Furnace Charging Device. An illustrated description of the Backlund & Burman furnace charging apparatus and its operation. 1700 w. Ir Age —Dec. 29, 1904. No. 66937.

Dry Air.

The Application of the Dry-Air Blast to Blast Furnace Operation (Die Verwendung von Trockenem Gebläsewind im Hochofenbetrieb). A full account of the Gayley dry-air blast as applied at the Isabella furnace. 3500 w. Stahl u Eisen—Nov. 15, 1904. No. 66883 D.

The Dry Air Freezing Process at the Isabella Furnace (Congélation de l'Humidité de l'Air Soufflé aux Hauts Fourneaux Isabella, pres Pittsburgh). MM. Picard & Heurteau. A brief account of the Gayley process of drying the air blast by freezing out the moisture. 1000 w. Comptes Rendus—Nov. 21, 1904. No. 66841 D.

The Influence of Drying the Blast on Blast-Furnace Performance (Influence Exercée par la Desiccation du Vent sur la Marche des Hauts Fourneaux). A. Lodin. A discussion of the Gayley dry air blast process, indicating that the reported economy may be due to other causes. 1200 w. Comptes Rendus—Nov. 28, 1904. No. 66842 D.

The Use of Dry Air in Blast Furnaces (Sur l'Emploi de l'Air Sec dans les Hauts Fourneaux). Henri Le Chatelier. An examination of the Gayley dry air process, showing that the economy may be due to the operation at a lower temperature. 1000 w. Comptes Rendus—Nov. 28, 1904. No. 66843 D.

Electro-Metallurgy.

See Electrical Engineering, Electro-Chemistry.

Furnaces.

The New Cleveland Furnace. Brief, illustrated description of the plant of the Cleveland Furnace Company. 2400 w. Ir Age—Dec. 22, 1904. No. 66742.

Handling.

Mechanical Handling in the Manufacture of Iron and Steel. James N. Hatch. The influence of labor saving machinery in the steel industry upon national economy. 4000 w. Engineering Magazine—Jan., 1905. No. 66894 B.

Iron Working.

Iron and Its Early Manufacture in England. A. R. Bell. A brief review of the early history of iron working in England. Ills. 2000 w. Mach. N. Y. Dec., 1904. No. 66605 C.

Iron Works.

The Jeanesville Iron Works Company. Illustrated description of a modern plant arranged with a view to obtaining low shop cost and the greatest perfection in the product. 1400 w. Ir Age—Dec. 1, 1904. No. 66465.

Magnetite.

Genesis of the Magnetite Deposits in Sussex Co., New Jersey. Arthur C. Spencer. Shows the geologic relation of these magnetites, and the manner in which they were formed. 2000 w. Min Mag—Dec. 1904. No. 66518 C.

Pig Iron.

The Classification and Valuation of Pig Iron (Einteilung und Bewertung des Giessereiroheisens). Oscar Simmersbach. With especial reference to the grading of German pig iron according to the percentage of silicon. 3000 w. Glückauf—Nov. 19, 1904. No. 66882 B.

Separators.

Electro-Magnetic Separators of the Secondary Induction Type. Explanation, with illustrated description of the Knowles magnetic separator and its operation. 3000 w. Mines & Min—Dec., 1904. No. 66567 C.

Sulphur.

The Use of Manganese Ore as a Desulphuriser in the Melting of Pig Iron

(Ueber die Verwendung von Manganerzen als Entschwefelungsmittel beim Schmelzen von Gusseisen). Dr. Wedemeyer. With analyses from a number of trials, showing the beneficial action of manganese ore in remelting. Two articles. 5000 w. Stahl u Eisen—Nov. 15, Dec. 1, 1904. No. 66886 each D.

Wisconsin.

Iron Ores of Wisconsin with Special Reference to the Baraboo District. S. Weidman. Read before the Science Club of the Univ. of Wis. Considers briefly the three kinds of iron ores in the state, especially describing the Baraboo district, its geology, deposits, development, &c. 4500 w. Wis Engr—Dec., 1904. No. 66907 D.

Progress on the Baraboo Iron Range. D. E. Woodbridge. Remarks on Mr. Weidman's conclusions as to the genesis of this ore, with information and opinions of W. G. La Rue. Ills. 2500 w. Ir Trd Rev—Dec. 29, 1904. No. 66948.

MINING.

Alkali Lakes.

The Alkali Lakes of the San Luis Valley. Prof. Herman Fleck. Read before the Western Assn. of Tech., Chem. & Met. Gives the location of these lakes, describing them and discussing their origin, general properties, &c. 1000 w. Min Rept—Dec. 15, 1904. No. 66702.

British Columbia.

Review of British Columbia Mining. H. Mortimer Lamb. 2300 w. Min Rept—Dec. 8, 1904. No. 66583.

Broken Hill.

Geology of the Broken Hill Lode. F. S. Mance. An explanation of the geology of these mines in New South Wales, giving views of various investigators, supporting the opinion that the lode is a saddle. 1500 w. Eng & Min Jour—Dec. 1, 1904. No. 66433.

Zinc at Broken Hill. F. H. Bathurst. An account of the big stores of zinc in the mines and in the dumps, and its value. 1400 w. Eng & Min Jour—Dec. 1, 1904. No. 66434.

Cleavage.

Cleavage. George F. Becker. Abstract from "Experiments on Schistosity and Slaty Cleavage." Bulletin No. 241, U. S. Geol. Survey. Describes phenomena found in rocks, giving theories explaining the causes. 1400 w. Eng & Min Jour—Dec. 1, 1904. No. 66432.

Computations.

The Computation of the Dimensions of Mine Workings (Die Berechnung der Abmessungen von Abbaufeldern). H. Kegel. A derivation of elaborate formulas for computing the most economical areas for mine workings. 10000 w. Glückauf—Nov. 19, 1904. No. 66881 B.

Concentration.

Concentration of Ores in Great Britain. James Tonge. Describes the general practice, giving the principal features of a number of the most modern plants. 3500 w. Mines & Min—Dec., 1904. No. 66574 C.

Crushing for Concentrating Work. Discussing the process of crushing; the types of machines, with special reference to the Blake crusher. Ills. 3000 w. Mines & Min—Dec., 1904. No. 66569 C.

Electric Power.

An Installation of Electric Power for a Quebec Mine. Describes the substitution of electricity, generated by water power, for steam power at the Eustis mine at Capelton, P. Q. The mine produces sulphur, copper and the precious metals. Ills. 2000 w. Can Min Rev—Dec. 31, 1904. No. 66797 B.

Electric Drilling, Dredging and Pumping. George E. Walsh. Information in regard to the cost of operation, and applications at various mines. 2000 w. Eng & Min Jour—Dec. 15, 1904. No. 66691.

Electricity in the Lanarkshire Coalfield. Abstract of a presidential address delivered by Robert Robertson before the Glasgow Local Sec. of the Inst. of Elec. Engrs. 3000 w. Col Guard—Dec. 16, 1904. No. 66911 A.

The Copper Age Reservoir. Brief description, with diagrams, of plans for a power plant near Victor, Colorado, which will furnish electric power to the Victor and Cripple Creek mines. A granite masonry dam will be built at a point having unexcelled natural advantages. 800 w. Min Rept—Dec. 15, 1904. No. 66700.

Electric Prospecting.

Ore Finding by Electric Waves. Extracts from a paper by Alfred Williams explaining the application of the Daft and Williams process. Ills. 2400 w. Elec-Chem & Met—Dec., 1904. No. 66659 C.

Machinery.

Labor-Saving Devices in Coal Mining. R. V. Norris. An account of the manner in which some of the labor problems in coal mining have been met by the introduction of improved machinery. 3500 w. Engineering Magazine—Jan., 1905. No. 66892 B.

Mine Air.

The Dust in the Air and the Gases from Explosives in Dolcoath Mine. R. Arthur Thomas and W. P. O. Macqueen. An account of an investigation undertaken to determine the amount of stone dust present in the air, the efficacy of water jets and other means for preventing dust, and the amount of gaseous impurities present after blasting. 2500 w. Ir & Coal Trds Rev—Dec. 16, 1904. No. 66929 A.

Mine Pumping.

See Mechanical Engineering, Hydraulics.

Mining Power.

Power Generation and Transmission in a Modern Mine. E. H. Roberton. A discussion of the peculiar limitations and requirements involved in the installation of power generating and transmitting installations in mines. 3000 w. Engineering Magazine—Jan., 1905. No. 66897 B.

Oregon.

Producing Mines of Eastern Oregon. Describes the formation of the country and gives information of the principal workings, with illustrations. 2500 w. Min & Sci Pr—Dec. 3, 1904. No. 66592.

Ore Washing.

Brown-Ore Washing in Alabama. Erskine Ramsay and Charles E. Bowron. An illustrated description of construction and method of operation of log washers, stating the conditions to which they are adapted. 1400 w. Mines & Min—Dec., 1904. No. 66572 C.

Pneumatic Drills.

Recent Trials with Pneumatic Rock Drills (Neuere Versuche mit Luftbohrmaschinen). F. Hempel. Tabulated results of experiments with a number of German rock drills, showing the work done for a given consumption of air. 1800 w. Glückauf—Nov. 12, 1904. No. 66879 B.

Pulp.

Stirring or Mixing of Liquid Pulp. M. P. Boss. Remarks on the types of mechanical mixers. Ills. 700 w. Eng & Min Jour—Dec. 29, 1904. No. 66952.

Queensland.

Certain Iron Ore, Manganese Ore, and Limestone Deposits in the Central and Southern Districts of Queensland. Lionel C. Ball. Illustrated descriptions of these deposits with account of their development. 9800 w. Queens Gov Min Jour—Oct. 15, 1904. Serial. 1st part. No. 66469 B.

Reduction.

Washoe Reduction Works, Anaconda, Montana. Illustrated detailed description of the most extensive plant of its kind in the world, treating about 5500 tons of ore in 24 hours. 3800 w. Min Wld—Dec. 24, 1904. No. 66787.

Separator.

The Blake-Morscher Electro-Static Separator. Ernest A. Weinberg. Read before the Inst. of Min. & Met. An illustrated description of this separator, with explanation of the principle involved, and giving some practical working results. 3700 w. Min Jour—Nov. 26, 1904. No. 66520 A.

Transport.

A Discussion of Methods of Underground Transportation. J. B. Porter. The application of mechanical power to mine haulage, and the economies thereby effected. 4000 w. Engineering Magazine —Jan., 1905. No. 66896 B.

Washington.

Mt. Baker Mining District. J. D. Bone. Illustrated detailed description, with map, of this mining district in Whatcom County and its development. 2500 w. Min Rept —Dec. 8, 1904. No. 66582.

MISCELLANY.

Clays.

Clays Found in South Carolina. Earle Sloan. The present number considers the clay bodies of the potter's art, sedimentary kaolins, paper stock kaolin, and fire clay. Ills. 2200 w. Brick—Dec., 1904. Serial. 1st part. No. 66516.

Diamonds.

The Premier (Transvaal) Diamond Mine. Stafford Ransome. A description of this mine with information concerning its working, the quality of the stones found, &c. 1800 w. Engr. Lond—Dec. 16, 1904. No. 66925 A.

Gypsum.

A Theory of Origin for the Michigan Gypsum Deposits. G. P. Grimsley. Reviews the geology of this district, explaining the generally accepted theory of origin, and outlining the theory for these deposits. 3000 w. Am Geol—Dec., 1904. No. 66905 D.

Magnesite.

Magnesite and Its Uses. Charles H. Spinks. Describes the deposits in California, and explains some of the many uses to which the ore can be put. 2000 w. Cal Jour of Tech—Oct., 1904. No 66416 C.

Natural Gas.

Natural Gas Pumping Plant at Hundred, W. Va. An illustrated detailed description of the station and machinery of this plant. 3000 w. Eng Rec—Dec. 17, 1904. No. 66683.

Laboratory.

A Modern Metallurgical Laboratory. Robert H. Bradford. An illustrated description of a complete plant for testing ores by various processes, at the State School of Mines, University of Utah. 1700 w. Mines & Min—Dec., 1904. No. 66575 C.

Lead-Zinc.

The Lead-Zinc Mines of Kansas and Missouri. W. R. Crane. An illustrated description of the present practice of mining and milling in the Joplin district. 4000 w. Mines & Min—Dec., 1904. No. 66564 C.

Oil Fields.

The Kansas Oil Fields. W. H. Heydrick. An illustrated article discussing the physical and commercial conditions. Map. 4700 w. Min Mag—Dec., 1904. No. 66517 C.

Phosphate.

Tennessee Phosphate. H. D. Ruhm. Abstract from *The American Fertilizer.* Describes the deposits and methods of mining. 1200 w. Eng & Min Jour—Dec. 29, 1904. No. 66950.

Tin.

Development of American Tin Deposits. Review of the industry by the United States Geelogical Survey. 1800 w. Ir Age—Dec. 8, 1904. No. 66541.

Tin in Alaska. R. L. Beals. Describes the locality where the known deposits are found. Ills. 1100 w. Min & Sci Pr—Dec. 10, 1904. No. 66707.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Heavy Sacrifice of Life on American Railways: Is it Necessary? Day Allen Willey. A discussion of the Casualties on American railways, and a comparison with European roads. 3000 w. Gunton's Mag—Dec., 1904. No. 66644 C.

Railroad Disasters in the United States. Egbert P. Watson. Discusses the causes of railroad disasters in the present day, attitude of the public, the best remedies available, etc. 2300 w. Ir Age—Dec. 29, 1904. No. 66938.

Baggage.

Report on the Question of Baggage (Subject XI, Littera A, for discussion at the 7th session of the Railway Congress). George H Daniels. 12800 w. 1 table. Bul Int Ry Cong—Nov., 1904. No. 66666 E.

Clearance.

Advantages to be Derived from a Railway Clearance System. J. W. Midgley. A review of the Southern Iron Car Line, Green Line, and other attempts at clearing. 5500 w. Ry Age—Dec. 9, 1904. No. 66576.

Development.

The Development of Economy in Railroad Transportation Since 1875. S. Whinery. A discussion of the factors which have led to the reduction in the cost of the ton mile. 3500 w. Engineering Magazine—Jan., 1905. No. 66898 B.

Fares.

Passenger Fares—An International Comparison. W. M. Acworth. Compares the Northeastern Railway of England with the railways of other countries, showing interesting results. 1500 w. Ry Age—Dec. 2, 1904. No. 66486.

International.

Statistics of International Transport (Statistique des Transports Internationaux). Gen. A. de Wendrich. A discussion of the necessity for a simplified system of regulating and recording international traffic on the Continental railways; with forms for recording statistics. 4000 w. Rev Gen d Chem de Fer—Dec., 1904. No. 66837 G.

Natal.

The Railways of Natal. J. F. Gairns. Illustrated description of their characteristics, trains and train service, traffic, etc. 6000 w. Cassier's Mag—Dec., 1904. No. 66457 B.

Problems.

Some Problems in Modern Railway Transportation. Philip Burtt. Extracts from a paper read at the meeting of the York Ry. Lecture and Debating Soc. Discusses problems bearing on the development and increase of business, and the economy. 4000 w. Transport—Dec. 2, 1904. No. 66619 A.

Train Orders.

The Middle Order and the "19" Order. H. A. Dalby. Discusses methods of handling train orders, especially the use of the "middle order." 2300 w. Ry Age—Dec. 2, 1904. No. 66487.

Visual Requirements.

Vision of Enginemen and Firemen in Railway Service: Some Factors Affecting Same. Dr. Nelson M. Black. An explanation of the trying conditions and the importance of perfect and quick vision, giving opinions of experts and conclusions. General discussion. Ills. 14400 w. Pro W Ry Club—Nov. 15, 1904. No. 66741 C.

Work Regulation.

Report No. 3 on the Question of the

Duration and Regulation of Work (Subject XV for discussion at the 7th session of the Railway Congress). G. L. Potter. For America. 16800 w. 4 tables. Bul Int Ry Cong—Nov., 1904. No. 66667 E.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

A Remarkable Runaway. Amos Judd. An account of an air-brake failure with a light engine and tender, and the cause. 600 w. Loc Engng—Dec., 1904. No. 66513 C.

The Christensen Air-Brake. Illustrated detailed description. 1400 w. Engng—Dec. 9, 1904. No. 66732 A.

Cars.

Corridor Carriage for the Cambrian Railways. Two-page plate, with description. 800 w. Engng—Dec. 16, 1904. No. 66921 A.

Locomotive Frames.

The Locomotive Frame Considered as a Rigid Beam with Spring Supports (Der Lokomotivrahmen als Starrer Balken auf Federnden Stützen). W. Lindemann. A discussion of the various arrangements of springs and equalizing levers as distributing the load upon the frames of a locomotive. 3000 w. Glasers Annalen—Dec. 15, 1904. No. 66830 D.

Locomotives.

A Locomotive in Service Sixty Years. Herbert T. Walker. Illustration, with details of an engine in use nearly sixty years on a branch railroad in Santiago de Cuba. 800 w. Sci Am—Dec. 3, 1904. No. 66449.

Freight Locomotives with Superheaters, 2-8-0 Type. Illustrated detailed description of new engines for the Canadian Pacific Railway. 1500 w. Am Engr & R R Jour—Dec., 1904. No. 66437 C.

Locomotives at the St. Louis Exhibition. H. W. Hanbury. The first of a series of illustrated articles describing the locomotives exhibited. The present number deals with the locomotives built at the Rogers Locomotive Works. 2000 w. Engng—Dec. 2, 1904. Serial. 1st part. No. 66636 A.

Narrow-Gauge Consolidation Locomotive. Illustrated detailed description of powerful locomotives constructed for the Mexican Railways. 400 w. Engr, Lond—Dec. 2, 1904. No. 66639 A.

New Passenger Locomotives for the Lake Shore. Illustrated description, with general dimensions of the new Prairie (2-6-2) type passenger locomotives just put into service. 500 w. R R Gaz—Vol. XXXVII, No. 25. No. 66444.

Special Locomotive Types. J. F. Gairns. Begins a series of articles illustrating and describing some of these types. The present number illustrates two engines of the "Fairlie type"—double locomotives. 900 w. Prac Engr—Dec. 2, 1904. Serial. 1st part. No. 66625 A.

The Northern Pacific Mikado Locomotive. Illustrated description of heavy freight engines of the Mikado type, 2-8-2. 500 w. Ry Age—Dec. 9, 1904. No. 66577.

The Richmond Compound. H. C. Ettinger. An illustrated article giving a description of the proposed functions of this type of locomotive, and discussing its diseases and remedies. 700 w. Loc Engng—Dec., 1904. Serial. 1st part. No. 66514 C.

Three Historic Locomotives—and Some Others. Herbert T. Walker. Brief description, with illustrations of the principal historical additions to the collection owned by the Field Columbian Museum, recently exhibited at St. Louis. 1200 w. R R Gaz—Vol. XXXVII, No. 27. No. 66672.

Vanclain Four-Cylinder Balanced Compound Locomotive. Illustrated description of locomotives of the 4-6-0 type recently delivered to the New York, New Haven & Hartford Railroad. 500 w. Am Engr & R R Jour—Dec., 1904. No. 66439 C.

Locomotive Tests.

Instructive Tests of a Baldwin Balanced Compound Locomotive. Gives results of tests comparing this locomotive with three simple engines. The results are of special interest. 1500 w. Am Engr & R R Jour—Dec., 1904. No. 66438 C.

Locomotive Trade.

See Industrial Economy.

Motive Power.

Rock Island Motive Power Committee Report. Extracts from the recommendations and suggestions of the committee. 2400 w. R R Gaz—Vol. XXXVII. No. 29. No. 66956.

Refrigerator Cars.

New Types of Refrigerator Cars. Describes standard refrigerator cars, Bashaw's car, Fugazzi's temperable car, Johnson car, Bohn system car, Coolidge's car, S. & S. Sales car, and the fish commission car. Ills. 4000 w. Ice & Refrig—Dec., 1904. No. 66503 C.

Resistance.

Train Resistance. W. J. Davis, Jr. Gives information of value based on tests made from time to time with electric cars operated under a wide range of conditions, and the resistances obtained by ammeter and voltmeter readings. 2500 w. St Ry Jour—Dec. 3, 1904. No. 66491 C.

NEW PROJECTS.

Asia.

Russia's New Great Railroad in Asia. From the London *Times*. An account of the Orenburg-Tashkent Railway, with information of interest in regard to the country traversed. 2000 w. Sci Am Sup—Dec. 3, 1904. No. 66454.

New Route.

The Great Western Company's New Route to the West. Illustrated description of the route known as the Castle Cary and Langport Railway. 1800 w. Engr, Lond—Dec. 9, 1904. No. 66735 A.

Simplon.

The Western Feeders of the Simplon Railway. Mr. Elskes, in *Schweizerische Bauzeitung*. 1700 w. 3 tables & fig. Bul Int Ry Cong—Nov., 1904. No. 66668 E.

PERMANENT WAY AND BUILDINGS.

Bridge Loading.

The Classification of Engines for Bridge Loading. C. D. Purdon. Describes a method of classification by which the strength of bridges and the weight of engines may be quickly compared to determine whether certain engines may be run over any division. 1000 w. Jour Assn of Engng Socs—Nov., 1904. No. 66699 C.

Circum-Baikal.

The Circum-Baikalien Railway (Die Baikal-Umgehungsbahn). A description of the difficulties, cost and construction of the section of the Siberian railway around Lake Baikal. 1000 w. Glasers Annalen—Nov. 15, 1904. No. 66828 D.

Culverts.

See Civil Engineering, Construction.

Cut-Off.

The Old Monroe-Mexico Branch of the Burlington. An illustrated description of a cut-off, requiring only the construction of 63 miles of new line to shorten the distance between St. Louis and Kansas City. 2000 w. R R Gaz—Vol. XXXVII, No. 25. No. 66442.

Floods.

Floods on the Santa Fe System. A. F. Robinson. Illustrated description of the remarkable results of floods on the Arizona division. 600 w. Ry Age—Dec. 16, 1904. No. 66693.

Rails.

On the Question of Rails for Lines with Fast Trains (Subject II for discussion at the 7th session of the Railway Congress). Report (No. 3) for America. P. H. Dudley. 31000 w. 14 tables & fig. Bul Int Ry Cong—Nov., 1904. No. 66664 E.

On the Question of Rails for Lines with Fast Trains (Subject II for discussion at the 7th session of the Railway Congress). Mr. Van Bogaert. Report for all countries, except America, Germany, Holland, Roumania, Russia, Denmark, Sweden, Norway and Switzerland. 24000 w. 1 table & fig. Bul Int Ry Cong—Nov., 1904. No. 66665 E.

Roaring Rails. H. L. Wilkinson. An account of an investigation into the cause of the rail surface being worn into a series of ridges which produce a deafening noise as the train passes over them. 2000 w. Ills. Engr, Lond—Dec. 2, 1904. No. 66638 A.

Roadbeds.

Oiled Roadbeds of Railways in California. Abstracted from Bulletin No. 2, Department of Highways of the State of California, Sacramento. 1700 w. Eng News—Dec. 1, 1904. No. 66424.

Shops.

Angus Locomotive and Car Shops, Montreal. Begins an illustrated detailed description of the largest railroad shop plant ever built and put into service at one time. A most interesting and instructive plant. 1400 w. Am Engr & R R Jour—Dec., 1904. Serial. 1st part. No. 66436 C.

Signal Lamps.

See Electrical Engineering, Lighting.

Signals.

Automatic Block Signals. Ralph Scott. Discusses siding protection, simple signal circuits, track circuit controlling, etc. Diagrams. 3500 w. Am Elect'n—Dec., 1904. No. 66495.

Block Signals and Other Safety Appliances as Used on Different Railroads. Jno. L. Davis. Concerning block signalling on a single track road. 5000 w. Pro St Louis Ry Club—Nov. 12, 1904. No. 66648.

Interlocking at St. Louis. Illustrated description of the interlocking plant controlling the entrance and departure of trains to and from the Union Station. 3-page plate. 1200 w. Ry Age—Dec. 16, 1904. No. 66694.

Station.

Norfolk & Western Station at Roanoke. Illustrated description of a fine passenger station under construction. 800 w. R R Gaz—Vol. XXXVII, No. 25. No. 66443.

The New Grand Central Station. Illustration, with brief description of a proposed station to be built on the present site. 1400 w. R R Gaz—Vol. XXXVII, No. 29. No. 66954.

TRAFFIC.

Suburban.

Suburban Traffic. Extracts from a report prepared by A. W. Sullivan for discussion at the International Railway Congress, with editorial. 3000 w. R R Gaz—Vol. XXXVII, No. 25. No. 66446.

MISCELLANY.

Foreign Practice.

Impressions of Foreign Railroad Practice. The present article deals especially with French methods, considering them the most scientific treatment given to the locomotive at the present time. 1500 w. Am Engr & R R Jour—Dec., 1904. Serial. 1st part. No. 66441 C.

Germany.

The Development of Railways in the Ruhr District from 1840 to the Present (Entwicklung der Eisenbahnen in Ruhr-Industriegebiet Während der Zeit von 1840 bis Jetzt). L. Koch. With tables and diagrams showing the growth of the railway systems of the iron and steel district of Germany. 4000 w. Glasers Annalen—Dec. 1, 1904. No. 66829 D.

Russia.

The Railways of Eastern Asia and the Russo-Japanese War (Die Eisenbahnen Ostasiens und der Russisch-Japanische Krieg). Dr. Franz Ritter v. Le Monnier. A review of the railway transport facilities of Russia and Japan, and their relation to military movements. Two articles. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 29, 1904. No. 66822 each D.

STREET AND ELECTRIC RAILWAYS

Bonding.

The Bonding of the Brooklyn Elevated Railway System. F. H. Parke. Illustrated description of the method of bonding a structure which has been in use some time. 3000 w. St Ry Jour—Dec. 24, 1904. No. 66776 C.

Boston Elevated.

Depreciation on the Boston Elevated Railway. Howard S. Knowlton. Information concerning the conditions on this road, and the work of maintenance as carried out. 1500 w. Elec Rev, N Y—Dec. 3, 1904. No. 66481.

Brakes.

The Efficiency of Power Braking in Street Railway Service, with Tests of Power Consumption of the Air Brake. Edward Taylor. An analysis of the conditions met with in the application of power brakes to electric equipment, with notes and facts in regard to tests made by the writer. 4000 w. St Ry Jour—Dec. 24, 1904. No. 66777 C.

Car House.

The Car House of the Subway Division, Interborough Rapid Transit Co. Illustrated detailed description of the building at 148th st. and 7th ave., New York. 2000 w. Eng Rec—Dec. 3, 1904. No. 66479.

Chamonix.

The Chamonix Railway (Le Chemin de Fer de Chamonix). F. Loppé. An illustrated description of the electric railway operated by the Paris, Lyons and Mediterranean Company from Fayet to the Swiss frontier. Serial. Part I. 2000 w. Revue Technique—Nov. 10, 1904. No. 66832 D.

Circuit Breakers.

Checking the Adjustment of Car Circuit Breakers. E. C. Parham. Suggests a method whereby the adjustment of a car circuit breaker can be tested in from one to three minutes. 1500 w. St Ry Jour—Dec. 31, 1904. No. 66986 C.

Construction.

Standards of Construction on the Indianapolis Northern Lines of the Indiana Union Traction Company. Illustrates and describes work on the latest lines of the company, which is the second largest interurban system in the United States. 2500 w. St Ry Jour—Dec. 17, 1904. No. 66704 C.

Cost of Power.

Cost of Power in Street Railroad Service. R. C. Carpenter. Gives tabulated results showing the actual performance of street railroad power plants operating under wide ranges of conditions. 1200 w. Sib Jour of Engng—Dec., 1904. No. 66656 C.

Electric Locomotives.

Rapid Transit and the Electric Locomotive. Howard S. Knowlton. Discusses the application of electric locomotives for suburban service, and the future outlook, the advantages and disadvantages, and the effect on the engineers running high-speed trains. 2500 w. Am Elect'n—Dec., 1904. No. 66493.

Electrification.

The Metropolitan Railway. An account of the opening of this newly "electrified" London railway, with illustrated description of the plant. 4000 w. Elect'n, Lond—Dec. 16, 1904. Serial. 1st part. No. 66918 A.

English Tramway.

The Electric Tramways of Preston. Illustrated description of the line, overhead equipment, rolling stock, etc. 2300 w. Tram & Ry Wld—Dec. 8, 1904. No. 66770 B.

Extension.

Paris-Orleans Electric Railway Extension. An illustrated article reviewing the history of electric traction on these lines, and describing recent extension and improvements. 4000 w. Elec Rev, Lond—Dec. 2, 1904. No. 66629 A.

High Speed.

High Speed Electric Railway Work. F.

W. Carter. Read before the Rugby Engng. Soc. Discusses the conditions of actual service; heavy trains taking power almost continually, train resistance, speed, &c., stating conclusions. 1600 w. Mech Engr—Dec. 24, 1904. No. 67012 A.

Heavy Traction.

Problems of Heavy Electric Traction. O. S. Lyford, Jr., and W. N. Smith. Considers some of the questions brought out in the engineering of the work in progress for the Long Island Railroad Co., describing particularly some of the simple things that were done to facilitate decision regarding motor equipment for cars. 7000 w. Trans Am Inst of Elec Engrs—Nov. 25, 1904. No. 66650 D.

Problems of Heavy Electric Traction. O. S. Lyford, Jr., and W. N. Smith. Abstract of a paper presented at meeting of the Am. Inst. of Elec. Engrs. An illustrated article describing changes to be made in the Long Island Railroad system, the electrification of the suburban service, etc. Also discussion. 7500 w. St Ry Jour—Dec. 3, 1904. No. 66490 C.

High-Speed.

An American High-Speed Electric Railway. A brief, illustrated description of the third-rail system between Aurora, Elgin and Chicago. 800 w. Tram & Ry Wld—Dec. 8, 1904. No. 66769 B.

Some Notes on High-Speed Electric Railway Work. F. W. Carter. Read before the Rugby Engng Soc. Considers in a general way the problem of operating high-speed passenger trains making few stops. 2800 w. Prac Engr—Dec. 16, 1904. No. 66914 A.

Improvements.

Division Terminal Improvements in New Jersey—New Shop Methods. An illustrated article describing new work recently carried out in the mechanical and electrical departments of the Public Service Corporation of New Jersey. 4000 w. St Ry Jour—Dec. 10, 1904. No. 66581 C.

Interurban.

Chicago & Milwaukee Electric Railroad. Illustrates and describes extensions and improvements, the installation of new power house and substation equipments, operating features, etc. 6500 w. St Ry Rev—Dec. 20, 1904. No. 66706 C.

The Joliet, Plainfield & Aurora Railroad. Illustrated description of this recently completed electric interurban line in Illinois. 4000 w. St Ry Jour—Dec. 24, 1904. No. 66775 C.

The Scioto Valley Traction Company. An illustrated description of the only line in Ohio operated by a third rail. 4000 w. St Ry Jour—Dec. 3, 1904. No. 66488 C.

Jungfrau.

The Jungfrau Railway and Tunnels (Die Jungfraubahn und der Bau ihres Tunnels). Paul Möller. With numerous illustrations showing the construction of the railways thus far completed, and the plans for the continuation to the summit. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 26, 1904. No. 66804 each D.

Local Service.

Local Electric Service of the Orleans Railway (Traction Electrique der Trains de Banlieue de la Compagnie d'Orleans). F. Paul-Dubois. A description of the generating station locomotives, rolling stock and operation of the Orleans railway between Paris and Juvisy, a distance of about 12 miles. 5000 w. 4 plates. Rev Gen d Chem de Fer—Dec., 1904. No. 66838 G.

London Station.

The Great London Power Station. Harold J. Shepstone. Brief, illustrated description of the great generating station at Chelsea, London, to furnish the necessary power for working the Metropolitan District and other London railroads. 1500 w. Sci Am—Dec. 17, 1904. No. 66663.

London Underground.

Underground Railways of London. Map and notes from the *Statist*, giving an idea of the extent of the transformation work in progress in changing the lines to electric power. 1700 w. Eng Rec—Dec. 31, 1904. No. 66962.

Mont Blanc.

Electric Railway Up Mont Blanc. Brief description of proposed line, with profile. 800 w. Ry Age—Dec. 30, 1904. No. 66967.

Moving Platforms.

Proposed Moving Platforms Under Thirty-fourth Street, New York. Illustrations showing the location and plans for this proposed subway to be used as a feeder to other lines. 600 w. R R Gaz—Vol. XXXVII, No. 28. No. 66767.

The Moving Platform for Local Passenger Travel. An illustrated description of the modern moving platform and its operation, with especial reference to the proposed construction in a subway of New York City under 34th st., or 35th st. 2300 w. Ry Age—Dec. 23, 1904. No. 66774.

Multiple-Unit.

The Conditions of Electric Traction on Metropolitan Railways (Des Conditions de la Traction Electrique sur les Chemins de Fer Métropolitains). Maurice Soubrier. A discussion of the advantages of the multiple-unit system, with especial reference to the rapidity and acceleration. Serial. Part I. 3000 w. Revue Technique—Nov. 25, 1904. No. 66833 D.

New Zealand.

The Wellington, N. Z., Tramways. Brief, illustrated description of the construction work. 1200 w. St Ry Jour—Dec. 3, 1904. No. 66489 C.

Operation.

Operating Features of the Seattle Electric Company. Gives details of car operation and the handling of the trainmen. Ills. 5000 w. St Ry Jour—Dec. 17, 1904. No. 66705 C.

Paris.

Underground Electric Railway Work in Paris. Francis Paul. An illustrated detailed description of new construction on the Paris Metropolitan. 2500 w. Am Elect'n—Dec., 1904. No. 66492.

Recent Developments on the Paris-Metropolitan Railway System. An illustrated account of the opening of a new section, and giving information in regard to the entire system. 2000 w. St Ry Jour—Dec. 31, 1904. No. 66985 C.

Portland, Ore.

Notes on the Portland Railway Company's System. A brief illustrated description of the Portland Heights scenic line and its operation. 6000 w. St Ry Jour—Dec. 31, 1904. No. 66984 C.

Power Plant.

Mechanical Features of the Twin City Rapid Transit Company's New Power Plant. Howard S. Knowlton. Illustrated description of the coal bunkers and conveyors, boiler plant, engine room, etc. 2500 w. Eng Rec—Dec. 10, 1904. No. 66615.

The Power Station of the Scioto Valley Traction Company. Illustrated detailed description of the plant at Reeses, Ohio, of a typical high-grade interurban railway. 2000 w. Eng Rec—Dec. 3, 1904. No. 66470.

Rapid Transit.

Rapid Transit Railroad Construction at Battery Park, New York. An illustrated detailed description of the reinforced concrete subway at the lower end of Manhattan. 4000 w. Eng Rec—Dec. 24, 1904. No. 66780.

The Philadelphia Rapid Transit Railway. An illustrated description, with map, of a partly underground and partly elevated structure in progress in this city, which will eventually prove one of the great urban rapid transit railways of the world. 5000 w. Eng News—Dec. 29, 1904. No. 66943.

Speed.

Average Speed and Speed Allowances. A. R. Fearnley. Read before the Assn. of Tram. & Light Ry. Officials at Wakefield. Discusses the speeds allowed on British tramways, suggesting an increase. General discussion. 4300 w. Tram & Ry Wld—Dec. 8, 1904. No. 66772 B.

Subways.

Proposed Passenger Railway Subways for Chicago, Illinois. An illustrated account of proposed subways and estimate of cost. 1800 w. Eng News—Dec. 22, 1904. No. 66765.

Tracks.

Permanent Way for Tramways. Charles T. Taylor. Abstract of a paper read before the Rugby Engng Soc. A discussion of details of track, rail bed or foundation, paving, etc. Ills. 4400 w. Elect'n, Lond—Nov. 18, 1904. No. 66618 A.

Tramways.

Running Powers. Stephen Sellon. Read before the Tram. & Lgt. Rys. Assn. Discusses railway working in England, and the advantages of running through cars without change, with summary of discussion, and letters from numerous tramway engineers and managers. 11000 w. Elec Engr, Lond—Dec. 9, 1904. No. 66725 A.

Vienna.

The Arrangement of the Underground Conductors of the Vienna Electric Tramways (Die Elektrische Einrichtung für die Unterleitung der Wiener Städtischen Strassenbahnen). P. Poschenrieder. With general plan of the system, and sections of the underground conduits showing the arrangement of the conductors. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 18, 1904. No. 66818 D.

Wheels.

Tramway Car Wheels and Rails. Some Notes on Cost and Maintenance. A. N. Banister. Read before the Assn. of Tram. & Lgt. Ry. Officials at Wakefield. Notes on cost and maintenance, with discussion. Ills. 5000 w. Tram & Ry Wld—Dec. 8. 1904. No. 66773 B.

Wisconsin.

Electric Railways at Green Bay, Wis. Illustrated description of the system of the Green Bay Traction Co., which was formed by the consolidation of several lines. 3000 w. St Ry Jour—Dec. 10, 1904. No. 66580 C.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Public Works. *m.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland. Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-w.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Bridges.

Types and Details of Bridge Construction. Part I. Arch Spans. By Frank W. Skinner. Size 9 in. by 6 in.; pp. vii, 294. Price, $3.00. New York: McGraw Publishing Company.

Mr. Skinner has prepared, in convenient book form, a classified record of examples of a number of the most noted arch bridges which have been actually constructed, omitting masonry arches. The collection includes wooden, combination, wrought-iron, and steel arches, for both highway and railroad service, and it is fully illustrated from photographs and from working diagrams, showing details of construction and methods of erection.

Such a record is of undoubted value, even though given, as in this case, with little or no expression of opinion, the engineer being left to form his own deductions from the material exhibited, a method which, while not perhaps well adapted for students, is probably to be preferred for the designing engineer. Most of the designs shown have been described and illustrated in the pages of the engineering journals from time to time, but it is a manifest convenience to have them gathered in book form for reference.

In some instances the methods of computation employed are given, the majority of the bridges are simply described, together with an account, in some of the more important instances, of the methods used in the erection of the spans. The bridges are classified as wood and iron arch spans, spandrel-braced arches, arch trusses, plate-girder arches, and in a few instances cantilever bridges have been included. The list of bridges described is not claimed to be complete, but the designs are very well selected, and the extent to which constructive features are shown renders the whole a typical reference set of the most important structures in various parts of the world. It is to be regretted that in many instances the names of the designers have not been given, as most of the works are of such importance as to make it desirable that the memory of the eminent engineers should be associated with their works, but this is only a slight omission, compared with the information which is furnished.

Electric Transmission.

The Electrical Transmission of Energy. A Manual for the Design of Electrical Circuits. By Arthur Vaughan Abbott, C. E. Size, 9 in. by 6 in.; pp. xxx, 675. Price, $5.00. New York: D. Van Nostrand Co. London: Crosby Lockwood and Son.

It is an excellent commentary on the development of the practical applied science of electricity that a treatise on electrical transmission which was originally written as recently as 1894 should have passed to its fourth edition, and especially that this fourth edition should be announced as having been entirely rewritten as well as enlarged. As the author himself says in his introduction to the new edition, since the appearance of the second edition in 1898, the practice of transmitting energy by means of electricity has extended by leaps and bounds until to-day one can hardly gaze from the window of a railway train without encountering the pyramidal cross arms of a transmission circuit.

Mr. Abbott has limited himself wholly to the subject of transmission, in which, however, he includes the mechanism of converters and transformers, but omits consideration of general power house machinery, as fully discussed elsewhere. The scope of the work is well indicated by a summary of the contents, which include a discussion of the properties of wire, an exhaustive treatment of aerial circuit construction, of underground circuits, and of special railway circuits. Methods of electrical measurement are treated, both from the standpoint of the physical laboratory and of the outdoor operator, while methods of distribution both by series and in parallel, are given extensive discussion. A chapter is devoted to polyphase distribution, and the work closes with a chapter on the cost of production and distribution.

A special feature of the work is the printing of the important tables and diagrams on separate sheets, folded into a portfolio in the back cover, from which they can be taken as loose leaves. This will doubtless facilitate their use, but may also permit them to get into the hopeless category of "lost, strayed, or stolen."

Foundations.

Ordinary Foundations, including the Coffer-Dam Process for Piers. By Charles Evan Fowler, C. E. Size, 9 in. by 6 in.; pp. xxvi, 314. Price, $3.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The object of this work is clearly stated by the author to be the provision of practical information concerning a department of work which has been largely left untreated because of the importance of discussing the construction of difficult foundations. A great and troublesome piece of foundation work naturally receives publicity in proportion to its magnitude, while the general engineer and constructor finds that by far the larger portion of his work is of an ordinary character, and requires simply a good acquaintance with what has been done by others under similar conditions. It is this knowledge of the practical working methods involved in ordinary foundation construction, with especial reference to the use of the coffer-dam methods of building bridge piers, which Mr. Fowler aims to supply, and his work will doubtless find welcome acceptance by many. A brief historical chapter is followed by an account of coffer-dam construction, illustrated by examples taken from current practice. Methods of crib construction are illustrated, with timber and sheet metal piling, together with a discussion of methods of stopping leaks, and driving piles. The practical methods of pumping a dredging are also treated, as well as the sinking of cylinders and caissons.

Having thus shown the practical working methods of reaching the basis upon which the foundation is to be erected, the remainder of the book is devoted to the actual construction of the foundation, including the location of piers, the use of various kinds of stone, data concerning cement and concrete, and timber piers and timber preservation. The appendix includes specifications for well-known dams, bridges, piers and coffer dams, and the work contains a number of useful tables of the properties of the materials required for foundation work.

Mechanical Movements.

Mechanical Appliances, Mechanical Movements, and Novelties of Construction. By Gardner D. Hiscox. Size, 9 in. by 6 in.; pp. 396. Price, $3.00. New York: The Norman W. Henley Publishing Co.

This work forms practically a supplement to the book of mechanical movements by the same author, and contains a number of interesting groups of movements not included in the former work. The various groups include lever combinations, power transmission, power measurement, various methods of power generation, transportation by railway, road, and water, gearing, horology, and a number of machine and factory appliances. An interesting portion of the book is that giving brief descriptions of a number of the devices which have been proposed in connection with the effort to produce a perpetual motion machine, these, it may be, serving to show to those who may yet be working upon that fallacy, that their ideas have been anticipated and that failure must surely follow.

Works of this sort bear the same relation to invention and machine design that the dictionary and the encyclopædia do to the literary worker. By having at hand a convenient reference giving the methods which have been adopted by others for the attainment of given results much time is saved, and in many instances some simple device is found to perform what a much more complicated apparatus might otherwise have been made.

In the modern drawing room the provision of a moderate library of well selected reference books is found to prove a marked economy, and among such works the best collections of mechanical movements will be found of great use, not only during the preparation of a design, but frequently in the decision as to the whole plan to be adopted before the details are worked out. Such works as these are also of much service to patent attorneys in conducting searches as to the novelty of devices under consideration, or proving the anticipation of claims under contest, and they belong to the reference shelf of every well selected engineering library.

Mechanism.

Elements of Mechanism. By Peter Schwamb, S. B., and Allyne L. Merrill, S. B. Size, 9 in. by 6 in. Price, $3.00; pp. vi, 264. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Primarily compiled in the form of notes for the use of students at the Massachusetts Institute of Technology, this work is now issued in book form as a text book, and as such it forms an acceptable epitome of such well-known treatises as Reuleaux's "Kinematics of Machinery," Reuleaux's "Constructor," Robinson's "Principles of Mechanism," MacCord's "Kinematics," Rankine's "Millwork and Machinery," Goodeve's "Elements of Mechanism," and Unwin's "Machine Design."

To have boiled down all that was in these important works was found impossible either in a student course or in a set of lecture notes, but the present work does give a condensed course which will enable the student, whether in a technical school or in private study, to obtain a general grounding upon which he can develop his work according to the demands of his future practice.

It might be suggested that in such a work the academic methods of developing the curves for gear teeth should be supplemented with some brief account of the methods now employed in the best shops for generating the true curves directly in the gear cutting machine, since some of these machines offer the most instructive examples of the manner in which the geometrical operations of laying out gear teeth have been rendered obsolete in the drawing room by their transference to the machine itself.

The book will doubtless find useful application as a condensed treatise on the subject, apart from its use as a text book in the institution for which it was designed.

Tanks.

Towers and Tanks for Waterworks. The Theory and Practice of Their Construction. By J. N. Hazlehurst. Second Edition, Revised and Enlarged. Size, 9 in by 6 in.; pp. x, 325. Price, $2.50. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The general importance of the subject of water towers and tanks and the propriety of a special treatise upon their construction is shown by the fact that a special book on the subject has reached a second edition within a short time. As the author says, it has been the custom to buy a stand-pipe in much the same manner as a barrel of flour, or any other staple article, the stipulations being only for size or capacity, with some statement as to the character of the workmanship. The natural result of such a method has been a disastrous record of stand-pipe failures, so that the previous book upon the subject, by Prof. Pence, was devoted entirely to the subject of failures and breakdowns. This portion of the work has been continued by Mr. Hazlehurst, although his book is primarily one dealing with the correct principles of design and methods of construction.

After chapters dealing with the strength of the materials employed, and the nature of the stresses to be resisted, Mr. Hazlehurst proceeds to consider the principles of design and the details of tank construction. With these are included discussions of the construction of foundations, erection, painting, and ornamentation.

The list of failures, including the work of Prof. Pence and the author, is sufficient evidence of the necessity for the employment of competent engineering advice in the design of such important structures as water towers, and in this book the principles are given with sufficient fulness to enable the waterworks constructor to make plans which should be satisfactory. It is to be regretted that the method of Professor Intze is not included in the discussion of the design of the bottoms of metal tanks, since this plan enables the form to be so proportioned that the horizontal stresses will exactly neutralize each other. The Intze form of tank bottom is now extensively used in Germany, and it is undoubtedly superior to the hemispherical form advocated by Mr. Hazlehurst.

The book is an excellent one of its kind, and a valuable addition to the list of treatise upon special structural subjects now becoming general.

Tools.

American Tool Making and Interchangeable Manufacturing. By Joseph V. Woodworth. Size, 9 in. by 6 in.; pp. 560. Price $4.00. New York: The Norman W. Henley Publishing Co.

Ever since the time of Eli Whitney, who at the close of the 18th century originated the art of interchangeable manufacturing as applied to firearms, the use of jigs and special fixtures has been in constant and increasing use in American workshops. The development of the art in the United States has been such that at the present time it well merits a special treatise, and this want has been supplied in the book which Mr. Woodworth has prepared. This is rather a descriptive than an analytical work, and in it are described and illustrated all the different types and classes of small tools, fixtures, devices and special appliances available for use in machine manufacturing and metal-working establishments. The appliances described in the book are taken from examples in actual and practical service in many shops throughout the United States, and it is by the employment of just such methods that the modern shop has succeeded in increasing outputs and thus reducing the proportion of general expense to the increase of income.

Formerly the methods and appliances which are described in such a book as Mr. Woodworth has made were kept closely guarded in the secret recesses of a special tool room and experimental department, but it is now recognized that the benefit gained by publicity and interchange of methods and information far exceeds that which can be secured by the old-time secretiveness, and the result appears in the fulness with which the author has been enabled to give the shop processes, tools, and methods of the leading manufacturing establishments of America.

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THE COMPENSATION OF LABOR.

By H. L. Gantt.

Mr. Gantt's paper following is probably the most comprehensive statement he has ever made of his view that all wage systems are "simply expedients to make employer and employee see the facts in the same light."—THE EDITORS.

IT has become an axiom in the commercial world that in the long run those transactions most promote prosperity which are advantageous alike to buyer and seller. It is coming to be realized in the industrial world that the same thing is true regarding the arrangements between employers and employees, and that no arrangement is permanent that is not regarded as being beneficial to both. In other words, the only healthy industrial condition is that in which the employer has the best men obtainable for his work, and the workman feels that his labor is being sold at the highest market price.

The employer who insists on more service than he pays for, and the employee who demands excessive wages for his work, both lose in the long run. The former worries continually about how to manage dissatisfied workmen who are continually on the verge of a strike, and in dull times the latter lives in constant dread that his employer may no longer be able to continue business and he may be out of work. The important thing for the average workman is not that he shall have exceptionally high wages during times of great prosperity, but that he shall have continuous employment and fair wages at all times; and it would seem to be the duty of the employer who makes large profits out of the services of his workmen during times of prosperity to see that these workmen shall have employment during times of depression. Granting this principle, which the most enlightened employers recognize as correct, the problem of the proper relations between employer and employee resolves itself into how to assure the workman practically continuous employment at fair wages.

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The answer to this is that it must be possible to meet all competition; in other words, manufacturing must be done at the lowest cost the available knowledge and appliances will admit of. The duty of an employer to his employees then demands that he shall maintain his plant and system of management at its highest efficiency, for only thus can he afford his men employment during times of sharp competition.

In other words, the expense of maintaining the efficiency of a plant up to the highest possible point is a legitimate charge on the earnings, and should be satisfied before any appropriations are made for dividends. In these days when scientific knowledge is increasing with such great rapidity and the means for utilizing it are being multiplied on every side, this charge is a large one, and alert manufacturers find that the percentage of the original investment that sufficed a few years ago to maintain their plant at its highest efficiency is today absolutely insufficient. This fact explains why plants whose names for years were synonyms for prosperity have gradually become less prosperous, and to day are scarcely holding their own by decreasing the wages of their employees. The next stage of such plants is to close indefinitely and to remain for years monuments to the short-sighted policy of their owners and the misfortunte of their employees.

The time to make provision against such a fate is not when sharp competition begins to show the need of it, but when prosperous times produce a large surplus of earnings. Out of such earnings ample provision should be made to take full advantage of all improvements in apparatus or management that are available.

When I speak of improving a plant, I do not necessarily mean enlarging it, but equipping it with the best and most efficient apparatus scientific investigation can suggest and ingenuity can devise.

When I speak of improving the system of management I mean the elimination of elements of chance or accident, and the accomplishment of all the ends desired in accordance with knowledge derived from a scientific investigation of everything down to the smallest detail of labor, for *all misdirected effort is simply loss, and must be borne either by the employer or employee.* In a proper system of management practically all loss of this character is eliminated, and the saving effected by this alone will usually pay all the expenses of the system and leave a handsome profit.

Wherever any attempt is made to do work economically, the compensation of the workmen is based more or less accurately on the efficiency of his labor. Very fair success in doing this has been accomplished in day work by keeping an exact record of the work done each day by every man and by fixing his compensation accordingly.

Piece work, in which the compensation is fixed per piece from past records, or by the judgment of the foreman, is a crude attempt at the same thing; but, on account of a lack of knowledge as to what could be done, it has almost always had unsatisfactory results.

Mr. Halsey's premium plan, by which a workman is allowed a portion of the saving he can make over past records, has been useful in awarding the workman a share in the saving made by his effort; but as the workman seldom has the ability, and never has the opportunity nor the appliances, to make a complete investigation of any problem, this method always falls short of the best results.

In order to get the best results, which, in case of a machine is the maximum product from it, and in case of a labor operation is its most efficient performance, four things are necessary:

First:—Complete and exact knowledge of the best way of doing the work.

Second:—An instructor competent and willing to teach the workman how to make use of this information.

Third:—Wages for efficient work high enough to make a competent man feel that they are worth striving for.

Fourth:—A distinct loss in wages in case a certain degree of efficiency is not maintained.

These four conditions for efficient work were first enunciated by Mr. Fred W. Taylor, and when they are understood their truth seems almost axiomatic. They are worthy of a very careful consideration.

We never know whether the knowledge we have on any subject is complete and exact until it has been subjected to the criticism of a complete scientific investigation. Many people who have been accustomed to seeing an operation performed in a certain way imagine they know all about it and resent the intimation that there may be some better way of doing it. Anybody, however, who carefully analyzes the sources of his methods will find that the mass of them are either inherited, so to speak, from his predecessor, or copied from his contemporaries. He will find he knows but little of their real origin, and hence has no ground on which to base an opinion of their efficiency.

Even such a simple operation as shovelling is done very uneconomically in many places. The writer has seen the same shovel used for coal, ashes, and shavings, and this when coke forks were available for the shavings. The foreman had apparently given the subject no study and was content if the men were at work. The idea of working efficiently had never occurred to him. This is, of course, an extreme case, but it is a real one, and all degrees of efficiency exist between this and the case where each workman is provided with the proper implement and given a specific task, for the accomplishment of which he is awarded extra compensation.

The knowledge needed to set such a task in shovelling is much more complete than is at first realized, for hardly any two substances can be treated exactly alike, and the same substance is often much harder to shovel from the top of a pile than from the bottom which rests on a hard smooth surface. In studying this subject the first element to be determined is the size of shovel, which must be gauged to hold the weight which it is most economical to handle.

The second element is how long it takes to fill the shovel. For sand, fine coal, ashes, etc., it makes no difference in loading the shovel whether the material is taken from the top or the bottom of the pile, but in egg coal, broken stone, or lump ore the difference is very great; for, while it is quite easy to get a full shovel from the bottom of a pile which rests on a smooth hard surface, it is in some such cases practically impossible to fill a shovel from the top of a pile without actually raking the material onto the shovel. Again, the distance or height to which the material is thrown is a factor in all cases, because the higher or longer throw takes not only slightly more time, but because it takes more energy. We see that each such operation is composed of a number of elements, which may be studied separately. Having determined each element, they may be combined in a number of ways under a variety of conditions. Knowing the time needed for an operation we can add the percentage of that time needed for rest, etc., which has been determined, and calculate just how many shovelfuls a good man can average per minute without overexerting himself. We can readily get this done if we offer the proper wages for doing it. Again, if the problem is the economical operation of a machine tool, we must first consider what the essentials consist of:

1.—The machine must be run as continuously as possible.

2.—The work must be done as rapidly as the machine will do it.

In order to conform to the first condition, the machine must be kept in such good condition that it is practically exempt from breakdowns; the work to be operated upon and the appliances needed for doing it must be supplied before the previous job is completed.

To do work as rapidly as possible, it must be carefully studied and planned out beforehand, and the tools and appliances must be the best obtainable. Complete written instructions must be furnished the workman, and the expert who planned the work must be ready to come to his assistance if he is not able to follow promptly the instructions given. If the expert is a really competent man for the work and is supplied with proper knowledge concerning the machine and what is to be done, he can set a task such as he himself can do and give detail instructions for doing it. Having reached this point it is only a question of paying the proper price to get it done.

The necessary conditions, then, for obtaining the maximum result are knowledge, an interpreter of that knowledge, and proper wages; but while these will usually produce the desired result they will not always maintain it, but must be supplemented by the fourth condition, namely; *a distinct loss in wages on the part of the workman unless a certain degree of efficiency is maintained.*

The importance of maintaining a definite degree of efficiency is readily understood when we consider that a properly equipped plant has only its proper complement of each kind of machine, and if the output of any one falls below a certain amount, the output of the whole plant is diminished in proportion and the profits fall off in a much greater ratio. This fact does not appeal to the workman who has made good wages for several days and concludes to "take it easy" for a while, unless he also feels the loss his "easy going" causes his employer. Mr. Fred W. Taylor, who was first, and for twenty years the only person to put these ideas in operation, devised his differential piece-rate system to cover this point.

Elementary time study as applied to shovelling has already been considered, and the differential-rate system consists in fixing for any piece of work two rates, one about 20 per cent. higher than the other. If the work is done in the time in which the study indicates that a good man fitted for the work and working at his best normal speed can do it, or in less time, the rate paid is the high one. If the time taken is longer than this, the lower rate is paid.

To take a concrete example; let us suppose that a man can turn ten axles in a day on a certain lathe and the high rate is 30 cents each. If nine or less are done he gets only 25 cents each. His pay then for ten is $3.00 and for nine is $2.25. The difference between the pay for nine and that for ten is thus so great that a workman will make every effort to do the ten if he has a fair chance of success. If, however, the stint is set so high as to make its accomplishment the exception rather than the rule, few workmen will strive for it. I have applied the same idea in my Bonus System, which as most satisfactorily operated is identical with the differential-rate system, except that the workman who fails to get the bonus gets simply his day rate instead of a lower piece rate.

The method of operation is to determine the time to be allowed in exactly the same manner as in setting a differential rate, and if the work is done in the time set or less to allow pay for the time set, plus an additional amount of time, usually varying from 20 per cent. to 60 per cent. of that time. The percentage needed to make workmen strive for the bonus varies according to the severity of the work; and, while it averages 33 1/3 per cent., may amount to 100 per cent. when the work is exceptionally disagreeable and severe. As stated before, the time set for doing any work must be that in which a good man can do it without over-exerting himself. This being the case, the exceptional man will make exceptional wages, for such a man will often be found who is 25 per cent. faster than a good quick man.

Among the difficulties of introducing this system is that of convincing employers of its possibilities, and hence their reluctance to award sufficient compensation to the employees to secure its successful operation. When, however, they realize that it actually does produce the maximum output of the plant, and that notwithstanding the increase of wages the cost is reduced to a minimum for that plant, they recognize the increased wages of the employees as their fair share of the increased profits. When this point has been reached harmonious co-operation between employer and employee becomes assured.

Disregarding the academic question as to whether wages in general are paid by capital or come out of the profits of the business, the fact that the increase of wages indicated is paid out of increased earnings makes the workman vitally interested in the subject of management, for a workman cannot hope to get even fair wages indefinitely, if the business is run uneconomically. *Every wasteful operation, every mistake, every useless move, has to be paid for by somebody, and in the long run the workman has to bear his share.*

Good management, in which the number of mistakes is reduced to a minimum, and useless or wasteful operations eliminated, is so different from poor management, in which no systematic attempt is made to do away with these troubles, that a man who has always worked under the latter finds it extremely difficult to form a conception of the former. The best type of management is that in which all the available knowledge is utilized to plan all work, and when the work is done strictly in accordance with the plans made. The worst type is that in which every man does his work as he thinks best. Between these two extremes are all degrees. The organization needed to carry out the former is complex; that needed to carry out the latter is simple. The output of a plant operated under the former is usually from two to five times as great as that of the same plant operated under the latter. Bearing this in mind, it can be readily understood how a plant that paid low wages and lost money under one system, might pay good wages and make a handsome profit under the other.

The subject of wages is then inextricably bound up with that of management. Poor management usually means poor wages. Good management means good wages, for the high efficiency demanded by good management can only be maintained by such wages as will attract good men and induce them to work at their highest efficiency.

GOLD MINING IN THE ANCIENT ROMAN WORKINGS IN SPAIN.

By Alex. Del Mar.

Mr. Del Mar is one of the leading authorities of the world upon the production and history of the precious metals and their use as money. He has been commissioner of mines, director of the United States Bureau of Statistics, a member of the most important monetary commissions, and author of epoch-making contributions on the subject of the precious metals. Of late years he has been engaged in examinations of gold, silver, and copper mines in various parts of the world for a London financial syndicate. His article following reflects the distinguished talents which have given him an international reputation.—THE EDITORS.

SPAIN was to the Romans what fifteen centuries previously Egypt had been to the Phœnicians, and what fifteen centuries later America became to the Spaniards—the Dorado, the Land of Gold, the Dream of Avarice. In Egypt one views almost with indifference the golden prisons of the Bisharee district, in which were immured those unfortunates whose requiem Diodorus has sung so pathetically—it was so long ago, the works are so primitive, and we know so little of the races who constructed or operated them. But such was not the case in Spain. There, the mining works were of the most stupendous character; while the pages of Livy, Pliny and Tacitus place before us not only the men who erected these works, but the manner of operating them, the measure of their product and, more than all, the tremendous social consequences to which the product gave rise. One has only to recall the Halcyon Age which followed the flow of the precious metals from America to Europe during the 16th and 17th centuries, say from 1550 to 1650, to realise the Augustan Age of Rome, when all the world, Egypt, Asia Minor, Greece, Noricum, Rhætia, Gaul, Britain and Spain, especially Spain, poured into her ample treasuries the golden tribute of her numberless criminals and slaves.

Many of these ancient mines and mining works have within recent years been made the subjects of commercial negotiation and have thus afforded to the engineering fraternity opportunities to investigate their history and the ancient mode of working them. It is this view of the Roman engineering works in Spain that it is desired to submit to the reader.

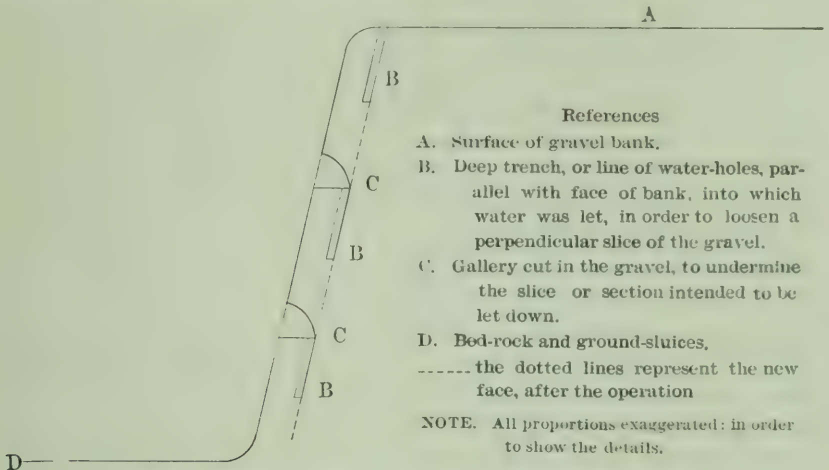
It happens that the most remarkable of these works—the gravel banks and hyyraulic works of Las Medulas—selected no doubt because they *were* the most remarkable—are alluded to in Pliny's account of gold mining in Spain. These works were situated about 28 miles from Monte Teleno, on the border line of the provinces Leon and Orense, near Lat. 42.28 North, Long. 6.50 East, embracing the mines, water-works, ground-pits, galleries, canals, sluices and booming apparatus presently to be described.

Originally the gravel banks rose from 50 to the almost incredible height of 750 feet above bed-rock, and covered an area of probably 1,500 acres, of which 1,000 acres, averaging 150 feet in height, were worked off by the ancients, leaving say 500 acres, rising from 500 to 750 feet above bed-rock as yet untouched and—it may be added—practically untouchable. The sketch opposite represents the present appearance of the gravel banks and indicates the method pursued by the Romans to break them down and run the gravel into the ground-sluices.

Pliny's account of the operation is much too long to be quoted entire. After describing the method of mining for quartz, and remarking that "the greed for gold" is even more insensate than the gold-enclosing rocks themselves, he turns abruptly to gravel-mining and says:—

> "When these operations are all completed, beginning at the last" (he hasn't said a word yet about gravel-mining; so that the text must be very imperfect or corrupt) "they cut away the timbers which support the roof, (of the gallery which has been cut along the face of the cliff,) the coming downfall gives warning when the time comes, and this is perceived by the sentinel who is set to watch for it upon a suitable elevation hard by. With voice and gesture he directs the workmen (below) to stand from under, and at the same moment takes care of his own safety. The mountain, rent by art, is cleft asunder, hurling its débris to a distance and with a tremendous tumult, which it is impossible for the imagination to conceive; and from the midst of a cloud of dense dust the victorious miners gaze upon this downfall of nature."

After describing how water is brought from a distance of many miles to the brow of these cliffs—of which more as we proceed—and how the fallen gravel is run through ground and wooden sluices, fitted with riffles of ulex to catch the gold, Pliny follows the gravel to the sea, the shores of which, he avers, are greatly extended by its deposition. Although he says nothing about the use of mercury for the purposes of amalgamation in mining for gold, there are reasons for believing that the ancients were well acquainted with this art:—1, the quicksilver mines of Almaden were worked by the Romans and upon a scale which it would be difficult to account for upon any other grounds; 2, the attraction between quicksilver and gold is mentioned by Pliny in another part of his work; 3, the name of the god Mercury, is believed to have been given to this metal in order to render sluice-robbery sacrilegious.



References

A. Surface of gravel bank.

B. Deep trench, or line of water-holes, parallel with face of bank, into which water was let, in order to loosen a perpendicular slice of the gravel.

C. Gallery cut in the gravel, to undermine the slice or section intended to be let down.

D. Bed-rock and ground-sluices.

------ the dotted lines represent the new face, after the operation

NOTE. All proportions exaggerated: in order to show the details.

ROMAN METHOD OF BREAKING DOWN GOLD-BEARING GRAVEL.

Pliny continues as follows:—

> "An equal labor (to mining) is that of bringing streams from mountain heights, for a distance sometimes of a hundred miles, to wash the gravel. The ditches formed for this purpose are called *corrugi,* and even when these are quite made, they entail fresh labors. The grade must be such that the water will run rapidly. Then, in places, it must be carried in flumes over gulches and valleys, or along the face of impenetrable rocks, which have to be excavated to receive the sluice-boxes; the workmen hanging suspended by ropes, like so many birds upon the wing. In this position they take the levels and trace with lines the course of the water. . . . . . When they have reached the brow of the cliffs (with the water), reservoirs are hollowed out a couple of hundred feet in length and breadth, and some ten feet in depth. These reservoirs are usually provided with five sluices, each about three-feet square; so that when the reservoir is filled, the sluice-gates may be struck away, when the mass of water descends with such violence as to sweep the very rocks before it."

To one who has visited these works it is abundantly evident that Pliny never saw them and that his description, notwithstanding its prolixity, is drawn from some other authority. As Pliny was Procurator in Spain about A. D. 66 and as such was entrusted with the management and collection of the revenue, a material portion of which was derived from the mines, it would seem strange that he omitted to witness personally the working of this very important one, unless at the period of his incumbency it was already exhausted and no longer in operation. Such was therefore probably the case. A peasant in the neighborhood of Las Medulas sold me a genuine aureus of the Emperor Nero, which he said had been found in one of the ground-sluices. As it was struck during the earlier years of that emperor's reign, A. D., 54-68, it may fairly be assumed that the works of Las Medulas were closed down about A. D. 60. From that time to the present—unless the Arabs of the Middle Ages essayed to attack its lofty flanks—the mine has remained unmolested, save by the birds in the day and the bats by night.

Close to the left bank of the river Sil winds the highway to Domingo Flores and Corunna, and on this highway stands the wretched hamlet of Carrucedo, from which to Las Medulas is under three miles. The ascent is from altitude 1,500 to 2,225, a rise of about one foot in twenty. The road winds through the "dump" of the mines, which is interspersed with immense stacks of boulders and cobble-stones, arranged with great precision, and covered with the gray moss of ages. Between these stacks, the dump is now laid out in cultivated fields, where, under the shade of hoary old chestnut trees, a dwarfed and impoverished growth of wheat struggles toward the sun. The road is steep, but it is bordered with wild roses and lavender; and one forgets the fatigue of the journey as he inhales their sweet perfume. Half-way up we stopped and gazed over the spacious fields which once formed the main sewer of Las Medulas and where myriads of Roman captives must have breathed their last, in the unremitting and savage drudgery of the mines. Here were assembled a vast host of unfortunates from all parts of the world, prisoners from Carthage and Judea, from Britain and from Egypt, flaxen-haired whites from the Baltic, wooly-haired negroes from Africa, freedmen from Rome (those who had been "ungrateful" to their patrons) and even legionary soldiers. This was the Siberia of the ancient empire, the golden prison beyond the sea, the "undiscovered country from whose bourne no traveler returned." Here all their laments were united; here all their hopes were dissolved; here all their sufferings were entombed. The stacks of boulders which they themselves erected are their monuments; the gray moss is their epitaph. So long as time shall endure, will these probably remain; for so vast is their bulk that it would require another army of slaves to remove them.

About an hour after leaving Carrucedo we reached Las Medulas. This pueblo consists of say forty or fifty houses, scattered about the upper portion of the ancient sluice-ways, which had many ramifications. The air of the place, when one does not venture too near a house or one of the inhabitants, is pure and refreshing. The women are the handsomest in Northern Spain, with countenances of a Roman cast. Instead of the *madrenyos*, or wooden shoes of the country, they wore leather ones, as in more civilised regions. The men were almost as handsome as the women. Ramiro, the son of our hostess, a youth of 20 years, was as neat a looking fellow as one might find in the Abruzzi. Roman, too, decidedly Roman. It was no longer a fancy—we were sure of it now. Some of the old legionary soldiers must have remained here, with their families, after the mines were abandoned by the Government; just as the Hessian soldiers settled in Pennsylvania, upon the close of the Revolutionary war. After a walk through the village, which proved to be as dirty as the other villages in this part of the country, we put up at the only house where the traveler can find entertainment at Las Medulas—that of the widow Carlota Ascasvero Lopez. In this house the hearth was composed of a raised platform of slate slabs, framed or bordered by logs. The domestic fire was built in the centre of this platform, and over it was suspended an iron pot. Long wooden benches were arranged on each of the two sides of the hearth, and here the family sat, while the pot boiled. The smoke, as in the other houses of this country, found its way out the best way it could. There was no chimney. In my bedroom there was a cot, a chair, a table, and a chest; all of heavy wood, hewn with adzes. In the chest were kept the bed-linen and towels. The washstand was a wooden bench on the porch. The fare at supper was coarse, but we fancied it was much cleaner than elsewhere throughout Leon. To bed at 9 o'clock and up at 4 in the morning, when, with Ramiro for a guide, we started to surmount Las Medulas.

It took an hour to reach the top, but the view well repaid the toil of the ascent. Towering up from the faintly descried village, their summits being the plateau upon which we stood, were the monstrous gravel buttresses of Las Medulas. Far below, on the right, wound the river Sil; on the left, the Cabrera; and at their junction, the town of Domingo Flores, bearing southwest by west. The intermediate country consisted of lofty hills and broken ridges, destitute of trees. Near the edge of the gravel cliffs wound the road from Orellan to Buenos Yrenes; and as we followed this around and crossed a saddle that led from the summit of the gravel cliffs to the mountain behind them, we came in sight of the Roman ditches which led the water to the ancient mines. Six of them are plainly discernible; some observers have made out a seventh. They are arranged one above the other, like so many parallel zones, carved upon the rocks. The lowest one was no doubt constructed first and the other ones subsequently, as a greater and greater altitude of water was needed to wash the mines.

These ditches are cut in slate, the stratification of which is almost perpendicular, as we have seen it in many parts of Nevada County, California. That it was not difficult to cut, is proved by the fact that the cart-wheels on the Orellan road have cut deep ruts in the same rocks, by merely passing over them. We jumped down into one of the ditches and examined it closely. It measures exactly five feet in width on the bottom. The width at the top is not so clearly defined, the elements having worn away the rock and broken down the outer bank; but we fancy it must have been over seven feet wide, with a rise of about three feet, exclusive of the bank formed by heaping up the excavated contents. The grade appears to be about twelve feet to the mile, although this could not be determined with precision, without tracing the ditch for a much longer distance than was deemed expedient. This is so different from Pliny's "rapid" grade that it almost seems that the text confuses the details of two different localities. The grade appears to be uniform; and to make it so, the Romans must have used a good leveling instrument; an inference that suggests the use of mercury for the purpose. In fact, the work appears to be thoroughly well done. Without the aid of gunpowder it seems wonderful that it should have been accomplished at all.

These ditches are 26 miles long; and as there are seven of them, the amount of rock-cutting was no less than 182 miles. The water was brought from the upper portion of the river Cabrera. Of course, the ditches have no water in them at present, nor have they had, for many ages; the ditches having been broken down long since. But enough of them remains to evince the skill, and the indomitable energy, of those who constructed them. Every inch of these 182 miles was chiseled out by hand, except where the ditches intersected depressions which had to be bridged by flumes. Myriads of lives must have been sacrificed in this work. It almost rivals in grandeur the famed pyramids of Egypt.

Half an hour after leaving the summit of Las Medulas we paid our bill and adieus at the village and were on our way back to Carrucedo. Below this hamlet—between it and the river Sil—more wonders remained to be explored. To appreciate these, it must be premised that the immense mass of debris that flowed down from Las Medulas was arranged to fall into the river Sil, but that on its way thither it accumulated in vast heaps, which the water from the base of the cliffs was inadequate to carry off. In order to wash it away and carry it into the Sil, resort was had to the device known in California as "booming."

Near Carrucedo and at an altitude of more than 1,000 feet below the bed-rock at Las Medulas, there anciently ran a stream which emptied by an acute angle into the Sil. This stream, which may be called the Rio Carrucedo, was dammed up by the Romans at a point above Carrucedo and its waters allowed to accumulate so as to form a lake, which still exists and is of such dimensions that it is several miles across. Below the dam they sank the river-bed 50 to 75 feet beneath its natural level; so that when the lake was let down, its flood might not damage the adjacent country. Into this sunken river-bed, and at right angles to it, flowed the debris of the mines Thence all the lighter portions were swept into the Sil, but the heavier portions remained and clogged up the sunken river-bed. To remove this deposit, the flood gates of the dammed-up lake were periodically removed, and the whole of its vast contents let down at once. The effect was not only to sweep away the deposit of boulders and cobble stones in the sunken river-bed, and to carry them into the Sil, but afterwards to urge them, together with the deposits of pebbles and sand in the Sil, down, down that swift river, until the entire mass was hurled through the Minho into the ocean.

The marks of these "booms" can be seen today along the rocky walls of the Sil. The operation must have been most terrifying. Imagine an impetuous rush of waters, 100 feet or more in height, charged with stones greater than cannon-balls, flying through a rocky defile, which, in many places, is not more than a few hundred feet in width! If the precision of the Roman rock-ditches commands our admiration, the magnitude of this booming apparatus must elicit something akin to reverence for its authors. One can scarcely regard one of our battleships, or the Brooklyn bridge, the Chicago water-works, or the hydraulic jets of California, without being impressed with profound admiration for the genius which planned and executed such gigantic works of art. When it is said that they all dwindle into insignificance beside the colossal works of Las Medulas, it will perhaps be understood what sort of miners the Romans were.

The same men who planned these works, turned the river Sil at a point lower down in order to "clean-up" its bed for gold. This was done by cutting, through a promontory of solid rock, a channel wide enough for the egress of the waters, and high enough for a sail-boat with main-sail up to pass through it. They built macadamized roads from these mines and others in the vicinity, to the eastern ports of Spain. They altered the entire face of the country, levelled its mountains, filled up its valleys, subdued it, tamed it, robbed it, ruined it, and then flung it to time and the elements.

Yet one takes his leave of their achievements with the same regret with which he turns his last look upon the Roman Forum, the Coliseum, and the arches of Titus and Severus. The men who erected these structures recked at nothing and knew no mercy; but both in the design and execution of their works, they were giants.

The guarded manner in which Pliny states the output of gold from Spain furnishes ground for the belief that, like America under Spanish rule, the Spanish mines yielded more gold than the Roman treasury received, or than was reported as having been yielded. He does not say that "the accounts in my office show the yield to have been" so much, but that "according to some authorities" the annual yield from Asturias, Galicia, and Lusitania—chiefly from Asturias—was 20,000 Roman pounds. In round figures, and assuming the gold to have been weighed before it was refined, this was worth in modern money (that is to say, it contained the same weight of fine gold as) four million dollars. If a fourth more be added for the gold secreted by the slaves, or smuggled out of the province by the lessees of the mines in order to escape the exactions of the mint, the total would amount to five million dollars. Such an amount, if it were all that was added to the gold coin and bullion in circulation and in the mints, banks, and treasuries of the world today, would be so inadequate as to occasion profound alarm. It would be far below the annual requirement to make good the wear and tear of coin; and thus would threaten the integrity of the stock of metal, and therefore the basis of credit. But if to that of Spain there is added the auriferous product of the other Roman provinces mentioned above, the total Roman product could hardly have fallen short of forty million dollars; and this, operating upon a comparatively small stock of coin and bullion throughout the connected commercial world, (which at that time scarcely went beyond the Roman pale), was quite sufficient to maintain prices and credit.

Another consideration to be held in mind was that Rome was in arms against the world and especially against those countries which possessed any substantial accumulations of the precious metals. Her accessions of gold and silver from this source, from the plunder of cities, of hoards, and even of graves, though smaller, were almost as regular as those from the mines.

The principal gold gravel mines worked by the Romans were the Sierra Nevada, Malaga; banks of the Duerna, Astorga, Leon; banks of the Sil, San Miguel, Leon; banks of the Sil, Ponferrada, Leon; Las Medulas, Las Medulas, Leon; banks of the Sil, Orense, Galicia; Cantabrian Pyrenees, Rio Burbia; banks of streams near Cordova; Guadalajara, near Madrid; banks of the Baza, near Granada; banks of the Tagus; Rio Tinto, Huelva; banks of the Burbia, near Villa Franca; banks of the Oria, near Cuevas; banks of the Eria, an affluent of the Duero; Monte Teleno, near Las Medulas, and the basin of the Guadalquiver. The principal gold quartz mines were Castropodame, San Miguel, Leon; Jadeña, 30 miles from Talavera de la Reina; San Domingo, Logroño, Old Castile; the Douro, near Oporto, Lusitania, and the gold and copper mine of Constantina, in Andalusia. The Tamaya mine, probably on the Tamega, is alluded to by Livy, but without mentioning its character. It was probably a gravel, or placer mine. The silver mines were Bebulo (now called Guadalcanal), near Cordova; Carthaga Nova, Carthagena, Murcia; the Sierra Morena mines in the mountains of Jaen; the mines in the Pyrenees mountains of Aragon; and the Rio Tinto silver and copper mines of Huelva. In addition to these, they worked the quicksilver mines of Sisapo, in Bætica, 27 miles N. N. W. from the modern Seville; and the celebrated Almaden mines of La Mancha. The Rio Tinto, Almaden, and one or two others of these ancient mines are still being worked: the first of these for copper, the second for mercury, the others for silver. Many of the ancient workings are fallen in and ruined. Castropodame proved to be a nest of snakes and a place of refuge for other unpleasant animals, some of them ready to oppose a vigorous resistance to any invasion of their domains.

The San Domingo quartz mines of Logroño, in Old Castile, were worked by the Romans in what may be termed a scientific manner. In some of them, adits were excavated for draining purposes, nearly three miles in length; whilst in others, with deep shafts, the water was raised to the surface by means of a series of gigantic wheels. Eight of these ancient wheels, all of them in a high state of preservation, have been recently found by the miners who are employed in workings contiguous to these old mines. The wheels are made of wood; the axles, where the greatest strain would come, being of oak, while the other parts are made of pine. As, in all probability, the quartz mines were not worked until the gravel mines were nearly or quite exhausted, the date of this machinery can hardly be fixed earlier than the second century of our æra. Nor, on account of known historical events, should it be fixed later than the beginning of the fourth century. About the year A. D. 200 is therefore a reasonable one for the period of the San Domingo waterwheels. They appear to have been worked on the tread-mill principle, by men standing upon one side of them, the water being raised by one wheel into a large basin and then lifted another stage by a second wheel; and so on in the same way by other wheels, until it reached the surface. In some of these ancient workings lead pipes have been found, but no iron pipes. No iron wire has yet been discovered in the ancient workings. In one of them, a wax tablet was found, containing arithmetical accounts relating to the mine; a proof that it was not worked without some regard to system and the rules of business.

The poverty of this portion of Spain is the best commentary on the present condition and availability of the mines. There are plenty of speculative miners, but no working ones. The wages of labor are pitifully low. At Priaranza, on the Duerna, the wages of farm laborers were 15 to 20 cents a day, women 8 to 10 cents; in both cases with maintenance; the latter costing 10 cents a day. Men who find their own maintenance charge 40 cents a day. They work from sunrise to sunset, except two hours for meals and a siesta in the fields. The age at which field-work is begun is from 12 to 14 for boys, and 13 to 15 for girls. Most of the latter become mothers before they attain the age of 16 or 17. At 20 they look old and worn-out; at 25 to 30 they become repulsive. The land-taxes are very heavy and form the chief source of discontent with the Government. A peasant at Las Medulas informed me that on one acre he paid $4 a year, besides 30 cents for *sedula de vicinidad* and 10 cents for each child over 14 years of age (and therefore, presumably able to till the fields). Altogether he paid $4 for land-tax and $1 for *sedulas*—a good deal of money for the owner of but one acre of land, or for a man whose labor throughout an entire year was worth only about $60: all these sums being couched in American gold coin. Besides this sum, he had also to pay customs and other indirect taxes on everything he consumed, except articles of indigenous growth; the principal commodities of foreign origin purchased by this class being hats, sashes, gew-gaws, hardware, cotton goods, sugar and spices: the silk sash and the gew-gaws probably costing more than all the rest.

THE LATEST TYPES OF INDUSTRIAL MOTOR VEHICLES.

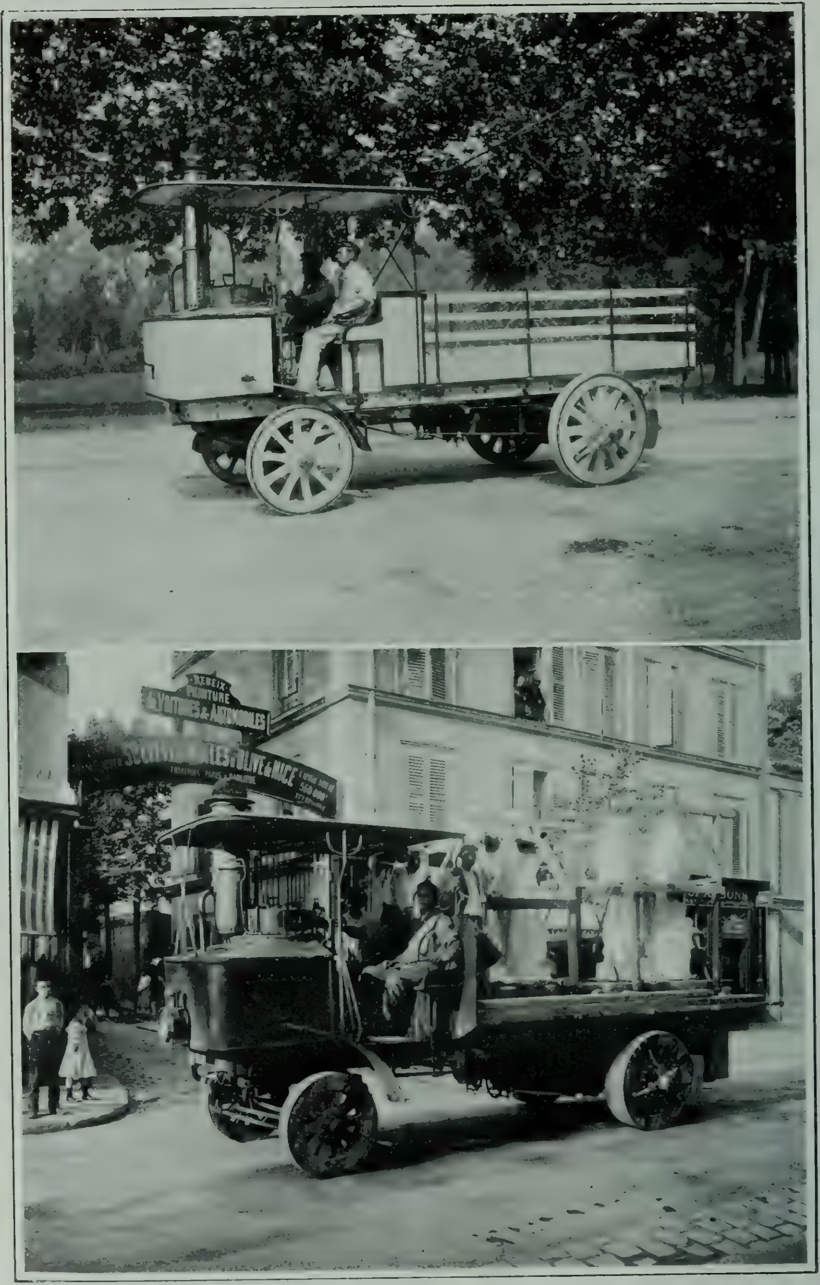
By Lucien Périssé.

Recent expositions on both sides of the Atlantic have offered opportunities to observe and to measure the advance in the construction of automobile vehicles and in their utilization in passenger and freight transportation. Monsieur Périssé is secretary of the technical committee of the Automobile Club of Paris, and he sums up the subject as it appears at present from the viewpoint of French and Continental practice and experience.—The Editors.

THE industrial automobile vehicle—called in France "heavy weight" (*poids lourds*) to distinguish it from the touring or racing type—comprises two general classes, passenger and freight. With the first of these we are not now concerned. They are, indeed, of subordinate importance where the railway service is well organised and comfortable, and where city transport is amply served by electric and street railways. But these conditions may exist, as they do in the United States, coincidentally with an inadequate network for freight distribution, and with common roads far inferior to those of the Old World. Further, it is of interest to observe that experience in France has shown that while public automobiles for passenger transportation have been remunerative only under exceptional conditions, practical success has always attended the use of motor vehicles for freight in extra-urban service, opening up the traffic for the extension of the railway or tramway.

The second category, therefore—freight motor vehicles—is that to which we are to devote attention, and here the automobile appears as an admirable industrial auxiliary—a time-saver of the same class as the machine tool, the hoisting or conveying installation, or the mechanical calculating device.

It is not to be supposed that we are face-to-face with the possibility of substituting automobile for rail transport over even moderately long distances, for by far the most costly element of all in road transportation is speed. Reference to the data of the subject will show that to move one ton of useful load at 6¼ miles an hour requires 2 horse power, while at 31 miles an hour the same load demands 15 horse power. To multiply the speed by 5, we must multiply the power by 7½. It was this relation which led Monsieur G.



TWO MOTOR VEHICLES OF HEAVY TYPE, DE DION-BOUTON MANUFACTURE.

The upper one is a 30-horse-power truck; the lower, carrying marble statuary, is of 50 horse power.

Forestier, the learned secretary of the automobile section of the Exposition of 1900, to remark that no change other than that of speed was needed to realise an economy of 25 per cent. The heavy motor vehicle must rest upon its usefulness for transportation at low speeds—say 6 to 8 miles an hour; but even this is much more rapid than horse haulage, which for heavy wagons does not exceed 3 miles an hour. *

Industrial transportation by motor vehicle is most appropriate in the cases of the movement of material within very large works, or between the separate works of a single company; carriage from the factory to the railway; carriage from the factory to points of further transformation or to centres of distribution; and delivery from the factory, within the city or in its environs. In short, whether it be needed to take the yarn from spinning to weaving mill, or the woven fabric to the dye works, or the finished cloth to the railway; to transport the sugar from an out-of-town refinery to warehouses or wholesale depots; to take meat from the stockyards, or coal or ice from storage places; or to bring milk from the surrounding country into town—the heavy-load motor vehicle finds most useful application.

The light industrial automobile, on the other hand, is most useful for delivery service in or about the city—delivery of merchandise of all sorts—wearing apparel or other purchases which the buyer requires with the briefest delay, or provisions, such as milk, fish, or ice, which will not keep long; for the assemblage in one factory of material such as milk for butter or cheese making, or fruits and vegetables for preserving—in such service the light motor vehicle finds its *raison d'être* and its certain success. We may then make the following natural classification of industrial automobiles:—

1.—Heavy motor vehicles, of 2 to 5-tons useful load, and speed not exceeding 6¼ miles an hour.

2.—Light industrial automobiles, (trucks or delivery wagons) with a net-load capacity of ½ ton to 2 tons, according to the specific gravity of the material carried, the mode of packing, and the space occupied by the articles. The speed varies according to the load and the conditions of transportation, and may reach as high as from 9 to 12½ miles an hour.

On the other hand, we have a classification known to all which is based on the kind of motive power employed, and by this the vehicles are grouped into three classes—steam, liquid-fuel, and electric. We

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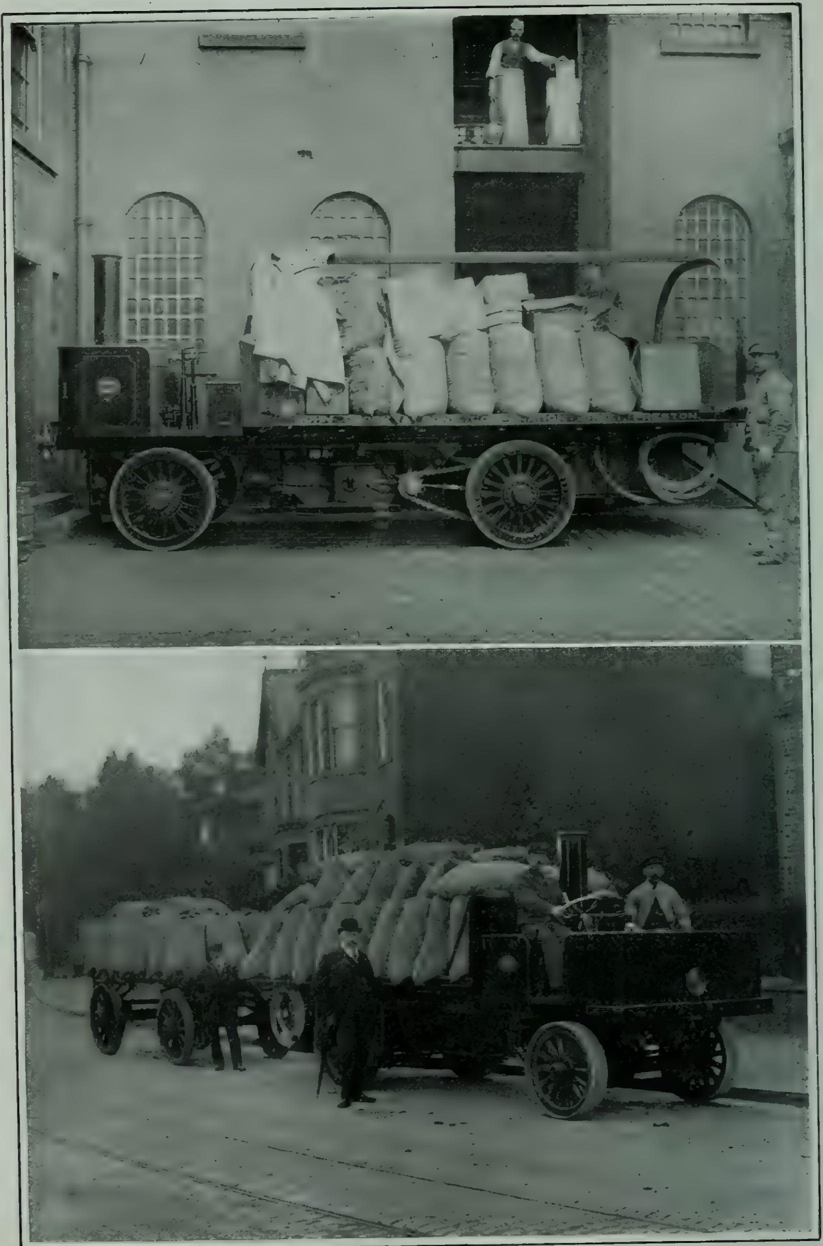
* The speed of a draft horse is from about 1 to 2.2 miles an hour, depending upon the work he is doing.



BRITISH TYPES OF HEAVY MOTOR VEHICLES.

The upper one is a large motor truck made by the Lancashire Steam Motor Co.; the lower is a 6-ton steam motor lorry, with a 10-ton load, made by T. Coulthard & Co., Ltd., of Preston.

shall see that steam vehicles are well adapted to the requirements of the first class, above designated as "heavy," while those driven by liquid-fuel motors or by electricity are much better suited to the work of the second, or "light," class. Consideration of the advantages and disadvantages of each system may serve to determine the conditions under which the various types will be respectively best adapted to industrial use.

The steam automobile has essentially the quality of great elasticity. The operator can give it its maximum or its minimum power by the simple movement of a valve. If there is a stretch of bad road or a heavy grade ahead, a little turn of the throttle valve sends the vehicle forging strongly ahead under the impulse of the high-pressure steam. If, on the other hand, it is necessary to run at the slowest possible speed through a crowded thoroughfare or past a frightened horse, the throttle may be closed until the heavy wagon moves on without jar, without noise, and without danger.

Unhappily, to offset these advantages we have the fact that all steam systems of automobile propulsion involve a large dead weight, including under this term the weight of the vehicle itself and that of the motor and its supplies. Improvements have indeed been made from year to year, but they have not arrived at the point of removing the defect of damage to the roadway caused by the heavy weight on the axles and the tearing of the road surface by the driving wheels. Further, the effort has been to increase the speed, and this can be effected only by decreasing the "load efficiency."* For instance, taking the weights and the load efficiencies of the trucks exhibited by one firm at the competition of "heavy weights" organized by the Automobile Club of France, we find the following figures:—

First year......	Total weight,	9.9 tons.	Useful load,	4.0 tons.	Load effic'y,	.44
Second year....	" "	8.8 "	" "	3.3 "	" " "	.31
Third year.....	" "	7.67 "	" "	2.4 "	" " "	.39

Reference having been made to the destructive effect upon the road surface exercised by heavy loaded trucks, it becomes of interest to cite figures furnished in 1901 by the engineers-in-chief of the Ponts et Chaussées in the various departments of France in which motor-car service has been established. In the department of Calvados, 10-ton omnibuses were run at 7.5 miles an hour; the width of the metal tires was about 5¼ inches. Although the service was infrequent, the additional expense necessary for the maintenance of the road was a little over 800 francs per mile per year. In the de-

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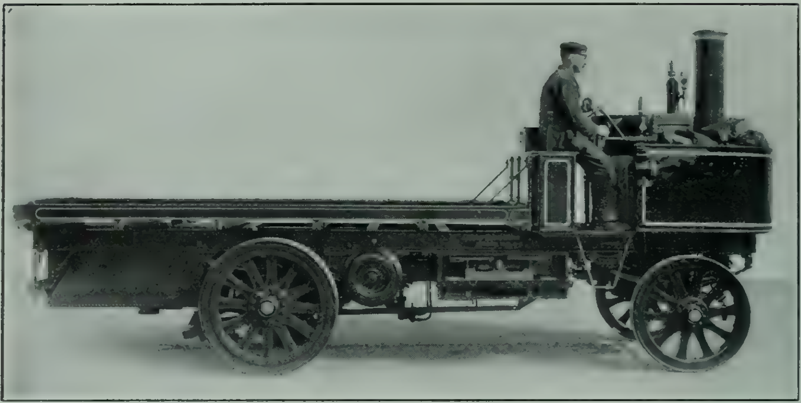
* The coefficient of load efficiency is the ratio of the useful load to the total weight of the loaded vehicle—that is, of net to gross weight.



FLAT-BODY LORRY WITH RIM SIDES, TO CARRY 4 TONS.

Over-all length 18 ft. 3 in.; carrying body, 12 by 6 ft.; speed 5 miles on the level; a trailer carrying 2½ tons may be taken. Thornycroft Steam Wagon Co., Chiswick and Basingstoke.

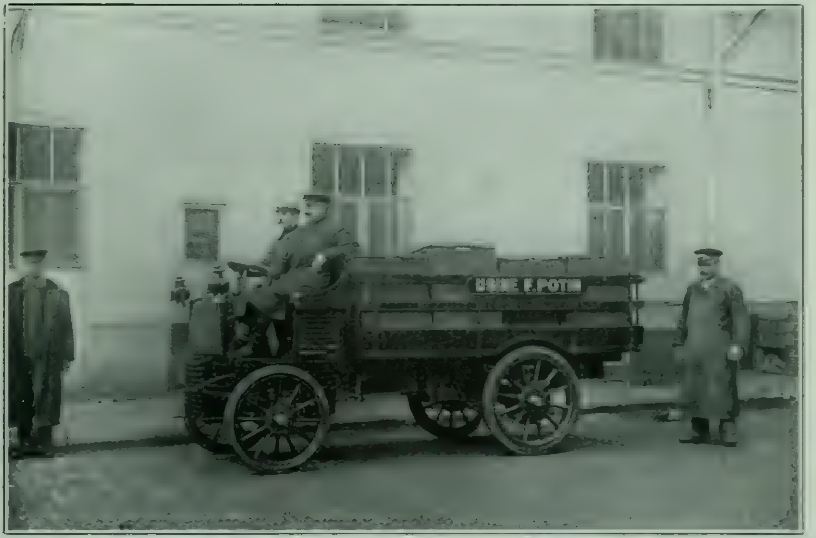
partment of the Loire, motor trucks carrying a load of 3 tons were put into use on a road upon which they had to surmount a grade of 11 per cent. They showed a notable economy over animal traction during the summer season, but not enough to compensate for the heavy additional outlay, amounting to a sum varying from 1,100 to nearly 1,300 francs per mile, necessary for the maintenance of the road in winter. This was due to the lack of proper solidity in the sub-soil, and to the frequency of the service, which extended over a circuit of less than 4½ miles, the trucks passing over the road at too short intervals for its proper maintenance.

When tractor vehicles are used, it is requisite (in order that they may have sufficient adhesion) not only to make them relatively heavy, but further to provide the rim of the wheels with projections, which leave their impression in the metalled surface of the road. It is generally acknowledged that even at low speeds the deterioration caused by wheels so made is considerable. In the department of the Oise, a road locomotive weighing 12 tons was used to pull a load varying from 6 to 10 tons, according to the kind of goods. The speed was from 2¼ to 3¼ miles an hour, and the corrugated felloes, nearly 19½ inches face, caused no serious deterioration so long as the road was dry; in the wet season, however, they dug up the road badly, and it is stated further that the wheels of the trailer, though they were more than 5-inch face, cut the road into deep ruts, costly to repair. In the Côtes du Nord department a service was installed in which the tractor vehicle had driving wheels of 15¾-

inch face, the load on each being 4.3 tons; there were two trailers, of 9-tons weight, loaded. The maintenance cost of the road, which was 750 francs per mile per annum with an annual traffic of 237 horses, rose to a little over 1,100 francs after the introduction of the motor vehicles, although these replaced one-third of the draught horses formerly employed; and even this outlay had to be increased later to maintain the normal up-keep, the excess being about 350 francs per mile per annum.

It is therefore apparent that in the use of steam vehicles, which are the heaviest yet perhaps the most convenient of all heavy weights, the primary consideration must be the roads over which they are to run. From this point of view, the lessons drawn by the British War Office from the Transvaal war seem to indicate that the steam motor vehicle is at least as serviceable on the veldt as on the open roads of civilized sections, and perhaps more so. One point is that on the veldt the trucks need not take always the same track, but may turn out from the beaten way and pick out the most convenient course; increase in the width of the face of the wheels adapted to the character of the soil will suffice to prevent their sinking in.

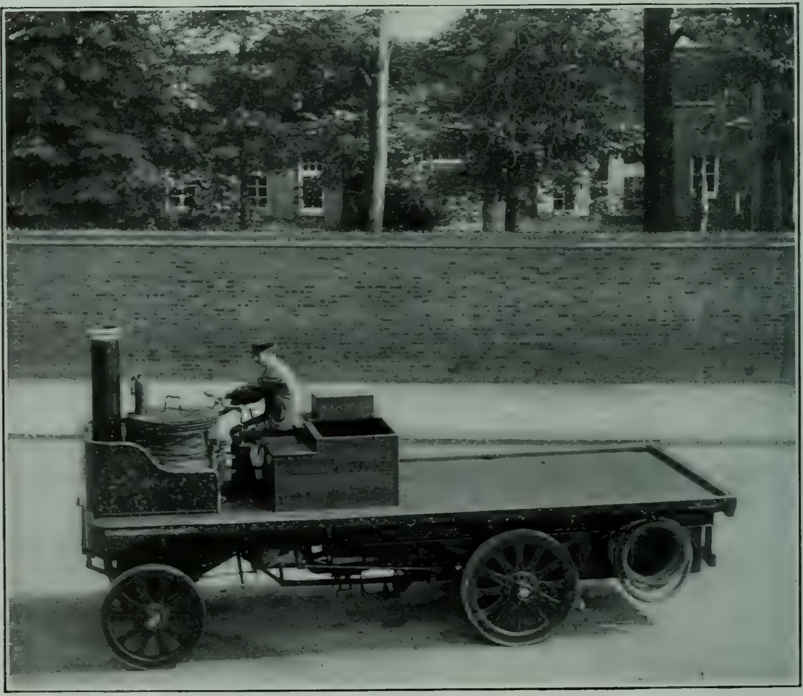
Among the English and French manufacturers who have attained marked success in the construction of steam vehicles, de Dion-Bouton, Purrey, the Thornycroft Steam Motor Co., and the



A 9-HORSE-POWER DE DION-BOUTON TRUCK, WITH LIQUID-FUEL MOTOR.

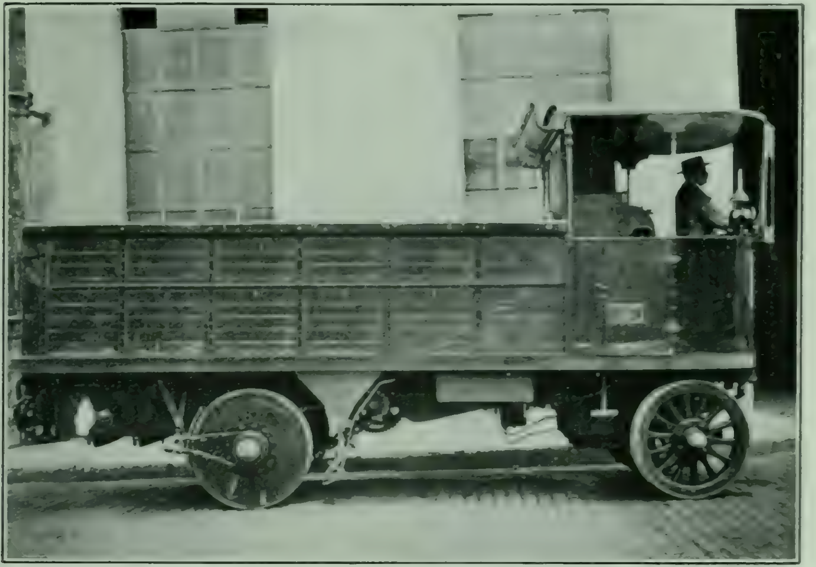
Lancashire Steam Motor Co., have devoted themselves especially to true motor trucks—that is, vehicles which themselves carry the load; the Société des Voitures à Vapeur Scotte and Monsieur Turgan, on the other hand, advocate the steam tractor, which tows loaded trailers. The mechanical features of both types are much alike—a small-tube water-tube boiler, with continuous feed; two-cylinder compound engines, placed forward under the chassis for tractors and toward the centre for trucks; transmission by gearing the rear axle or by chains to each wheel. All are designed to carry loads of 2 to 5 tons, on platforms of about 6 to 8-square-yards area. They have even been built to carry 10 tons net, but I am not at all disposed to favor these excessive weights, which involve many disadvantages.

Steam vehicles are in practical service in France and England in a great diversity of industries. In Paris may be seen a line of trucks built by Purrey, of Bordeaux, for the Say refinery. They have a closed box, for the transportation of sugar, and carry 10 tons daily. The boiler is of marine type, and the engine drives by chains the



THORNYCROFT SIDE-LOADING LORRY, TO CARRY 4 TONS.

rear wheels, which have been specially studied to carry safely the great load placed on them—about 12 tons on the rear axle. The trucks have a powerful band-friction brake. A huge van by the same builder is used to move pianos from the Pleyel manufactory.

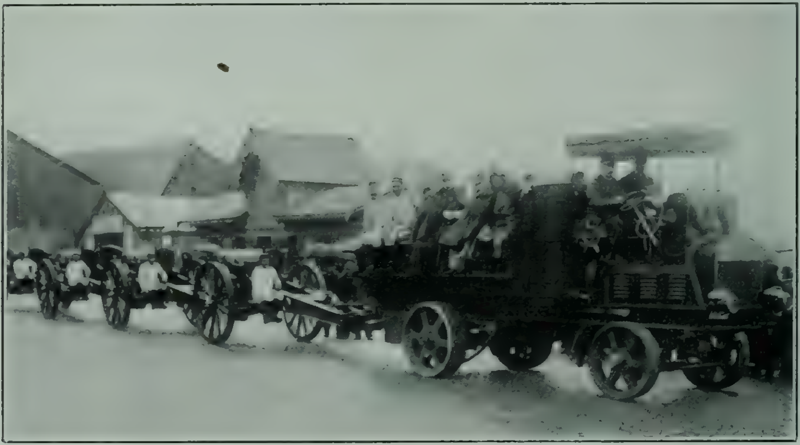


HEAVY STEAM TRUCK FOR THE SAY REFINERY.
Carries a 10-ton load; built by Purrey.

In England, following the War-Office tests in which Thornycroft received first prize, that maker has received various orders from municipalities, from the British and German ministries of war, and from some Indian governmental administrations. In France, neither the State nor any commune has as yet taken that course, because the competitions opened have too often shown that the operating cost of the steam vehicle was too high for our budgets. Exception must be made in the case of the steam sprinkler wagon built by de Dion-Bouton, which was placed on trial last summer in the Bois de Boulogne.

It would not be surprising, moreover, if it should soon become apparent in England also that the disadvantages already referred to are a great obstacle to the development of the steam vehicle, from the point of view of economy; and the remedy is not apparent, because evidently the dead weight of the steam automobile must always be great, whatever the perfection attained in other points of its construction.

Turgan and Scotte wagons have already proved, by ample working trial, that they are reliable in operation. The artillery bureau, the department of the engineer-in-chief at Versailles, the Austrian ministry of war, various colonial offices (such as those which have charge of mines and quarries or of the vintage in Algeria), and many manufacturing and commercial establishments, have adopted the tractors of these makers.

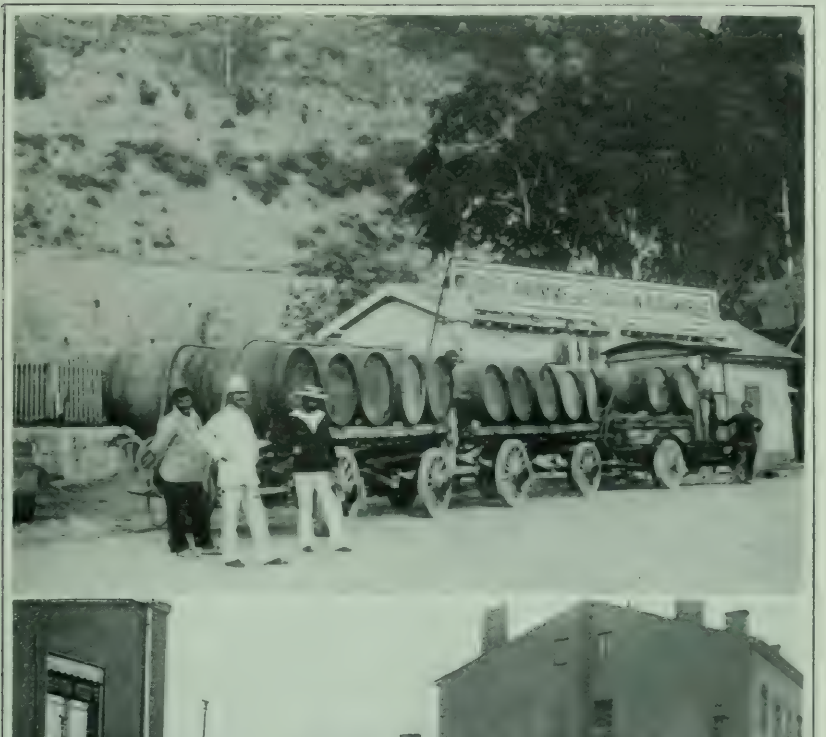


BATTERY OF ARTILLERY LEAVING THE LISBON ARSENAL, DRAWN BY A 40-HORSE-POWER BRILLIÉ TRACTOR.

Liquid-fuel motors—which might rather be called internal-combustion-motor vehicles—both those using light hydrocarbons and those using heavy, are built by many makers; for it is easy to construct a delivery wagon carrying 600 to 1,000 pounds, or a truck carrying from 1,000 pounds to a ton, with the chassis of a touring carriage. Whenever the load passes the ton mark, however, there is ample room for the careful study of the construction of the vehicle; and from that point of view the heavy-weight section of the International Automobile Exposition at Paris, in December last, was peculiarly interesting in its exhibits of recent work and study.

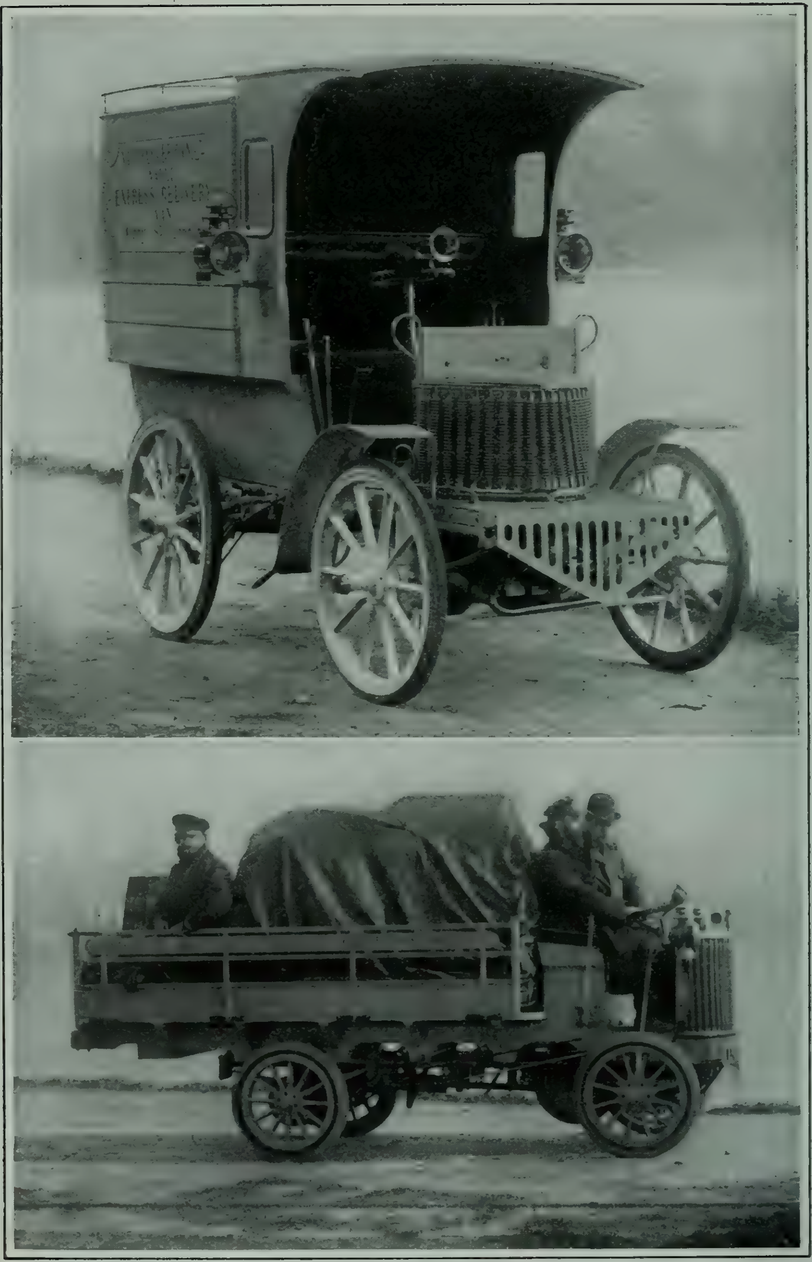
Monsieur Eugene Brillié, who has devoted a large part of his engineering career to the study of heavy motor vehicles, his automobiles being built in the artillery works at le Creusot, showed three types of trucks:—

1.—A tractor with 40-horse-power motor, for the Lisbon arsenal; this vehicle, which carries a live load of 5 tons, consisting of artillery supplies, tows a battery of large siege guns with a total weight of about 15 tons.



SCOTTE AUTOMOBILE TRAINS IN INDUSTRIAL TRANSPORTATION.

The upper one is hauling 24 hogsheads (“*demi-muids*”) weighing 16 tons, from Algerian vineyards. The lower is taking the under-body of a compressed-air tramway car, weighing about 19 tons, from the Lyons shops.



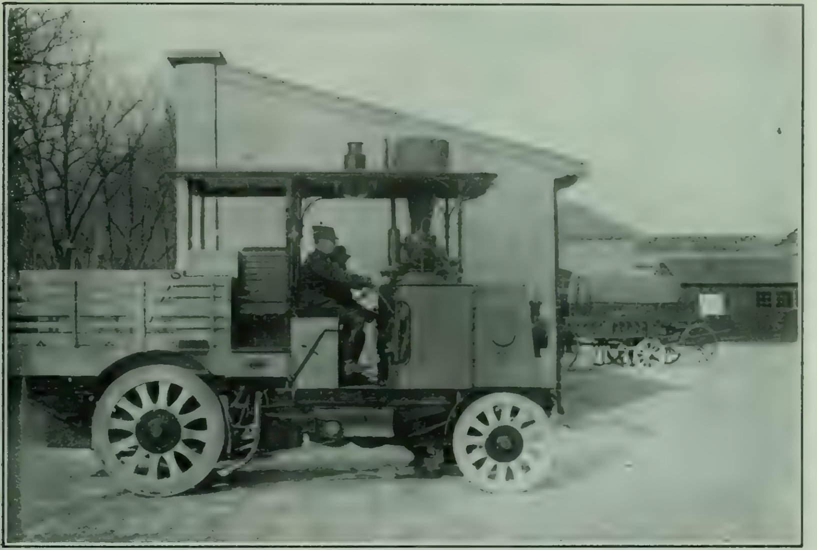
GILLET-FOREST INTERNAL-COMBUSTION-MOTOR VEHICLES OF VARIOUS TYPES.

The upper one is a delivery wagon, about 600-lb. load; the lower is a 12-horse-power truck, for a load of 2 tons.

2.—A truck with motors of 18 to 24 horse power, weighing 2¼ tons empty and carrying a load of 3½ tons.

3.—A light truck with 10 to 12-horse-power motor, carrying 2½-tons load on an empty weight of 2 tons.

The Société Française des Camions Automobiles Hagen has developed its construction, but the mechanical principles of the system remain as described in this Magazine in April, 1904. The truck exhibited was of 3-tons net weight, and carried a load of the same amount; the motor is of 14 horse power, giving a speed of 6 to 7½ miles on the level.



THE NEW SCOTTE MILITARY TRACTOR, MODEL ADOPTED BY THE FRENCH MINISTRY OF WAR.

A system which has been highly perfected during the past year is the fore-wagon of Monsieur Latil. This has the advantage over other systems of a very high load efficiency; a load of 3 tons can be carried in a vehicle weighing only half that much, giving therefore a load-efficiency factor of 0.75. The 12-horse-power motor is hung from the chassis, and transmits by universal joint to the front wheels; these, by a system of roller bearings, are made to act as both drivers and steerers. High mechanical efficiency is thus combined with complete practical utilization of the back portion of the vehicle. Thanks to this mode of arrangement, M. Latil has produced and exhibited a large van for carrying two horses, and this has just been put into use on the race-courses near Paris.

Among other builders of internal-combustion-motor vehicles for industrial use may be mentioned the Panhard-Levassor Co., Renault Bros., de Dion-Bouton, Delahaye, Peugeot, etc. The Société Gillet-Forest has retained the horizontal motor, permitting an excellent utilization of the surface of the chassis. This company is now contemplating a large automobile-carriage installation in Paris.

In this connection it is interesting to give the daily operating costs of two of the most frequently employed types of commercial vehicles. Type A is the small delivery wagon with 7 or 8-horse-power motor, carrying a maximum load of about a ton. Type B is the large van with 12-horse-power motor, a cubic capacity of 6 to 7 cubic yards, and a load-limit of about 1½ tons. We will assume a useful daily travel of 37½ miles. Garage is included in the general expense item, but in many cases garage will be secured on the shop or factory premises, and will therefore cost nothing.

	Type A francs	Type B francs
Gasoline (9½ and 14½ centimes a mile)..	3.60	5.40
Lubricating oil	1.00	1.10
Tires (9½ and 11½ centimes a mile)....	3.60	4.20
Repairs (9½ and 11½ centimes a mile)..	3.60	4.20
Motor man *(Mécanicien-conducteur)*.. ..	5.00	5.00
General expense, insurance, washing.....	2.10	2.40
Sinking fund	3.00	3.60
Total daily running expense	21.90	25.90

These figures, which of course apply to Paris, are notably lower than horse traction in that city.

Colonel Renard's continuous-propulsion road train, which we considered last year from the mechanical point of view on the appearance of the first specimen in the Exposition of 1903, was this year represented by a series of vehicles designed for the great butter-shipping enterprise of Messrs. Bretel Bros., of Valognes, Manche. The locomotors are equipped with 50-horse-power Abeille motors, tested for more than 100 consecutive hours by the windmill dynamometer. Great improvements have been made in the passenger vehicles by the adoption of a six-wheel type which permits good utilization of the chassis. Several industrial installations of the Renard road train are now under way toward organization in France.

CONTINUOUS-PROPULSION AUTOMOBILE TRAIN, RENARD SYSTEM.
50-horse-power liquid-fuel motor; net load 20 tons.

Important industrial use of automobile vehicles has been made in the French colonies, and notably in Madagascar. It may be of interest to survey them rapidly.

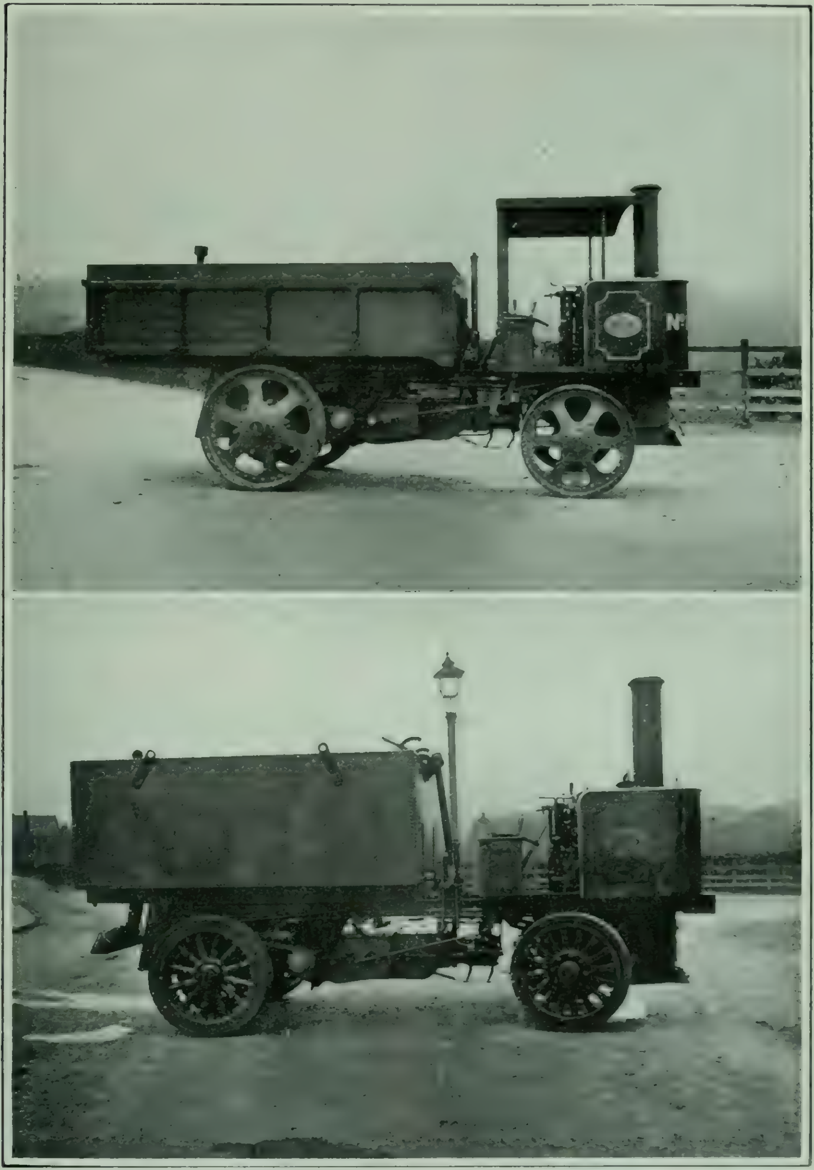
In the early months of the year 1900, General Gallieni, governor of Madagascar, took out with him three Panhard-Levassor cars, and the first trials were made before the completion of the road from Beforona to Tananarivo. This road was finished January 1, 1901, and Captain Grüss, ordnance officer to the governor, was at once charged with the organization of a regular service. Trial trips were arranged, the supply service organized, and the improvement of the road carried on until on May 20, 1903, an order of the governor instituted the mail service between Mahatsara and Tananarivo which went into operation June 1 following. In 1904 Captain Grüss made a most interesting detailed report; from this it appears that the road followed between Mahatsara and Tananarivo is 155 miles long and runs through mountainous country, with many curves but with maximum grades of 9 per cent only. The "rolling stock" consists of six automobile trucks of 15 horse power, and two 12-horse-power brakes, all of Panhard-Levassor make. Ordinary mails weigh from 1,300 to 1,800 pounds, but the French mail attains a weight of 5,500 to 6,500 pounds and the eight automobiles are sometimes overloaded and require thorough inspection after each trip.

The automobile drivers are colonial soldiers, almost all machinists by trade, and their apprenticeship on the road has been so carefully directed that each vehicle can be safely trusted to the one operator aided by a single Malagassy assistant. Repair shops and stores of repair parts are distributed along the road, as well as gasoline-charging stations. The 15-horse-power vehicles are arranged to carry four passengers, and in addition to officers and officials, many persons apply for passage on the automobiles, although the two-day trip to Tananarivo costs 192 francs, while the same journey may be made in native vehicle *(pousse-pousse)* in five days at a cost of only 150 francs.

In seven months the motor vehicles made a mileage of 28,500 and carried 106 tons of mail, 185 passengers, and 7 tons of personal baggage. The total net cost was 89,000 francs. The running expenses were therefore 5.40 francs per ton mile, or 840 francs per ton for the carriage of the mail the whole distance of about 155 miles to Tananarivo. For the same service, individual contractors were formerly paid 1,000 francs a ton, and the journey occupied five or six days. The transport by automobile is therefore advantageous from a pecuniary standpoint, as well as in the matter of time. Pending the completion of the railway, of which a 60-mile section was opened November 1, 1904, the automobiles will keep Tananarivo in regular and quick communication with the coast.

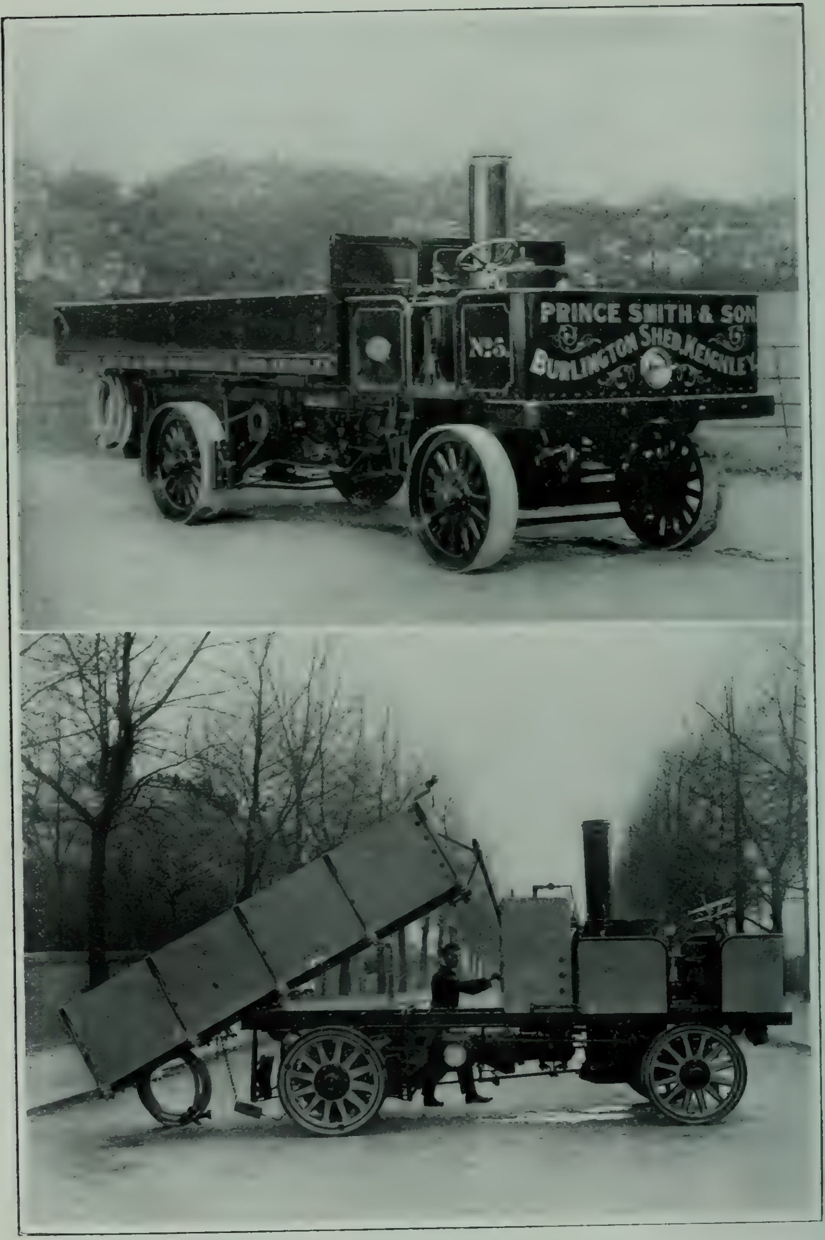
Of electric automobiles I shall speak but briefly; the number employed in France is limited to the city delivery wagons of establishments such as the Louvre and the Bon Marché, which are placed on an ordinary electric-carriage chassis. Electric vehicles for industrial purposes, in fact, have not come into use even where power could be obtained at very low cost, partly because the dead weight is considerable—larger even than in the steam vehicle—and partly because the maintenance of modern accumulator batteries is very burdensome, especially in the case of vehicles subject to the vibration, the jolting, and the shocks of city-street travel. Nevertheless. it ought to be said the Société des Automobiles Krieger and Messrs Mildé & Co. build electric delivery wagons which give excellent service in any case in which the rather high running expense is offset by the advantages of the very smooth running of the vehicle.

The Krieger company show a gasoline-electric truck—that is, one in which a gasoline motor drives a dynamo from which current is distributed to motors driving each wheel. The generating set may be used for operating a large search light when the truck is at rest.



MOTOR VEHICLES BUILT BY THE LANCASHIRE STEAM MOTOR CO.

The lower one is a convertible tip-wagon and watering van, 5-ton or 1,000-gallons capacity; 8-in. weldless steel tyres, wheels chain driven through the spokes, internal expanding brakes. The upper figure is a 4-ton colonial wagon, body steel-lined, wheels steel throughout; fire-tube boiler.



RECENT TYPES OF COULTHARD MOTOR VEHICLES.

The upper one is a 6-ton steam-motor wagon; the lower is a 4-ton steam-motor tipping vehicle.

The Paris post office also introduced, in 1904, a large number of high-speed vans for the rapid handling of the mails within the city. In brief, the construction of electric automobile vehicles has reached a point of such perfection that they may be employed with entire safety for delivery wagons up to 3½-tons total weight. Beyond that, the internal-combustion-motor type becomes the most advantageous.

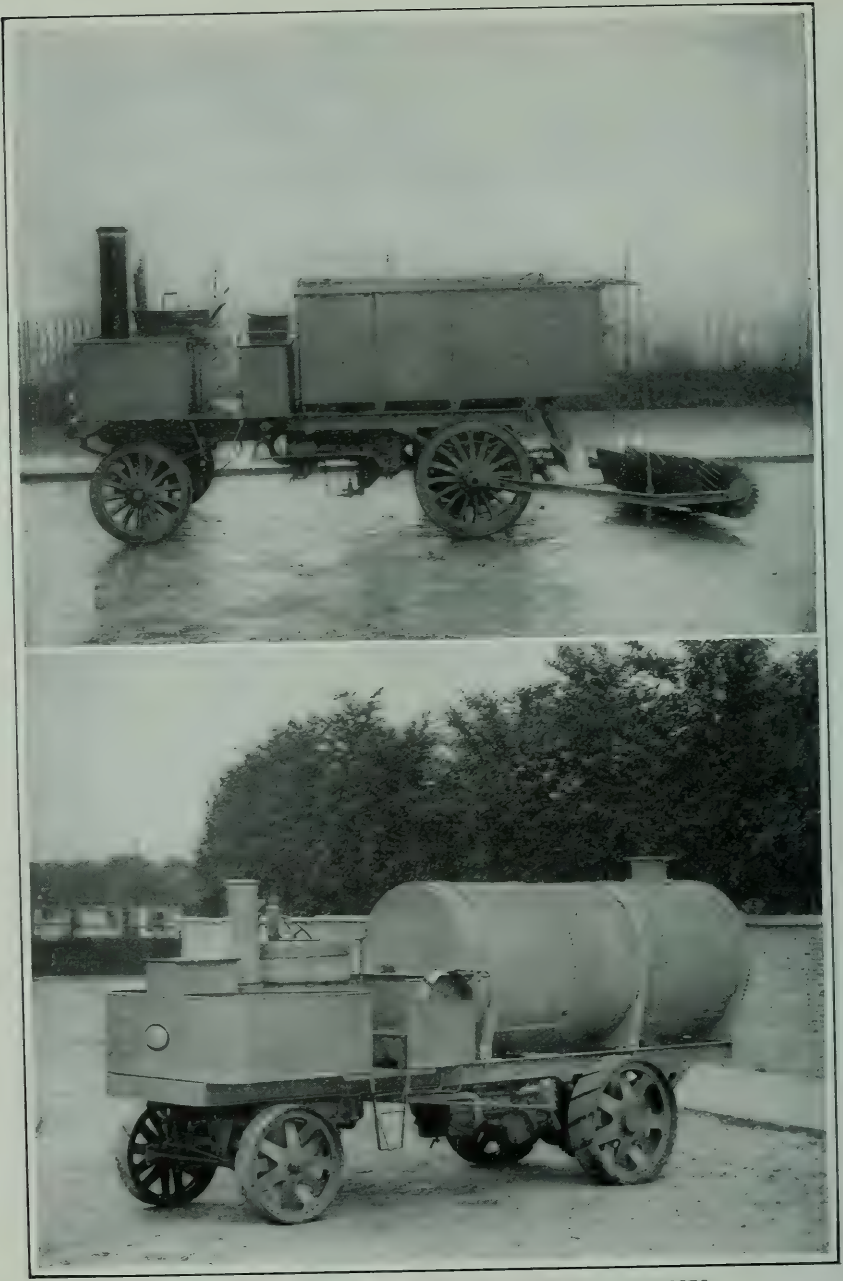
The automobile has become available as an industrial-transport agent because its construction has been perfected to the point where certainty of operation and of running can be guaranteed. Progress in the manufacture of liquid-fuel vehicles, moreover, assures a large reduction in the item of repairs (which constitutes an important element in the running expense) and for these reasons:—

1.—The metals employed in automobile construction have been selected by the results of long experience, and they have a higher resistance with smaller weight than was obtainable formerly. Nickel and tungsten steels, nickel itself, phosphor bronze, the alloys of aluminium—these are constantly used now for parts requiring special strength or special lightness. These improvements have been perfected through the knowledge gained in the great races organized in France, which inspired and stimulated studies by which the whole automobile industry is now profiting.

2.—Modern high-class machine tools, of which a very large proportion are of American origin, permit the mechanical production of parts with great accuracy and absolute interchangeability—an essential condition of manufacturing on a large scale.

3.—Finally, the arrangement of the various parts is now determined by the principles of an exact experimental science, quite sufficiently developed to dictate certain general types as combining the best economy in manufacture with the greatest facility for inspection, maintenance, and repair. Intending users need no longer be deterred, as they have been too often in the past, by the annoyances of a badly placed screw, or a spark coil continually out of order. Again it is to the races, and especially to the English "Reliability Trials," that we owe the important advances toward perfection made in the last few years.

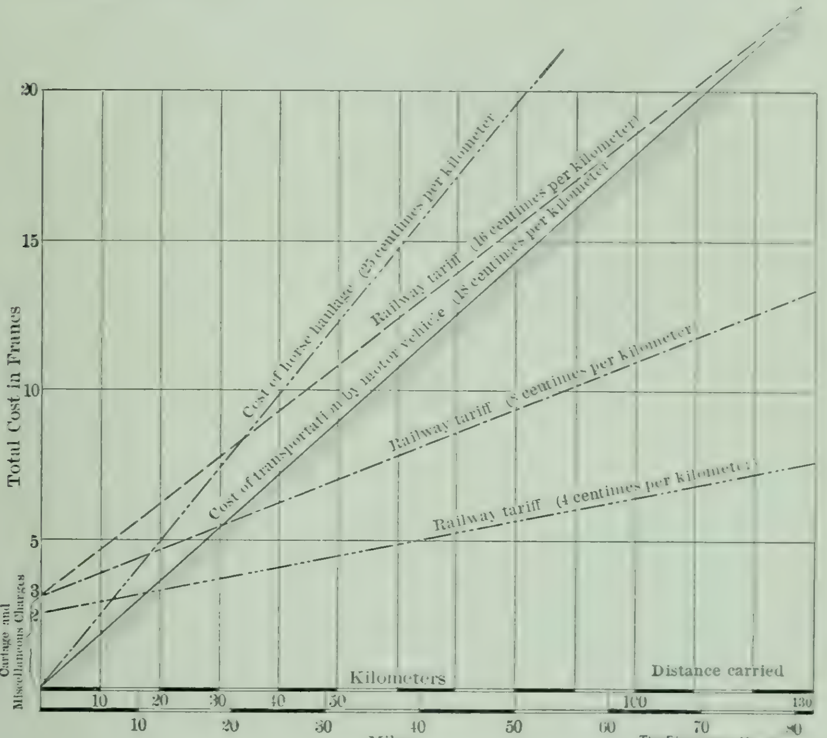
Liquid-fuel vehicles may be replaced by electric within city limits, where cost of operation is subordinated to other considerations. For the transportation of heavy merchandise, which is requisite in certain industries, recourse must be had to steam; but this demands very firm roads, and in any case it is prudent to limit the speed to



THORNYCROFT STEAM WAGONS FOR SPECIAL PURPOSES.

The upper one is a street-watering and sprinkling wagon; the 700-gallon tank is interchangeable with a tipping body. The sweeper is removable, or replaceable by a squeegee. The lower picture shows a tank wagon to carry up to 7-tons load.

6 miles an hour on the level and the weight to 3 tons on any one axle, so as to limit the deterioration of the road to a figure compatible with industrial economy.



The Engineering Magazine

CHART OF RELATIVE ECONOMY OF TRANSPORTATION BY VARIOUS AGENCIES.

In any comparison of transportation costs, as between the automobile and the railway, it must be borne in mind that railway carriage implies trucking to and from the station, and incidental charges for storage, etc., which average in the total two or three francs per ton on all classes of merchandise. It then becomes plain that up to a certain distance the automobile which carries the goods from door to door must be the most economical. I shall not attempt to give absolute figures, for railway tariffs in different countries differ widely according to the circumstances of the business, the districts, and the weight hauled. In France there are three tariffs, 4, 8, and 16 centimes per ton per kilometre (about 6½, 13, and 26 centimes per ton per mile); platting, on a graphic chart, curves based on these figures and putting in curves for the automobile and for horse haulage—the former at 18 centimes and the latter at 25 centimes per ton per kilometre (29 and 40 centimes per ton per mile) we obtain the results shown in the accompanying figure. Carriage by automobile is more economical than carriage by rail, at any particular tariff, up to the distance represented by the point at which the curve corresponding to that tariff enters the shaded area of the "domain of the automobile."

It is thus apparent that for merchandise paying the railway tariff of 4 centimes per ton per kilometre, carriage by automobile is the more economical up to a distance of 18 kilometres (11¼ miles); on the 8-centime per ton per kilometre tariff, the automobile is the more economical up to 30 kilometres (18½ miles); and on the 16-centime tariff, the automobile holds the advantage in economy up to 130 kilometres (81 miles).*

It is therefore plainly impossible to say absolutely that transportation of goods by automobile is more economical or less economical than similar carriage by rail. Manufacturers must study the particular conditions by which they are confronted, and it is only by taking these all into account that the solution of any particular case can be determined.

There is, however, no question whatever that mechanically propelled road vehicles are now potential utilities of the utmost value to the manufacturing industries, and that the occasions for their profitable employment will become the more frequent as manufacturers become better informed of the agencies at their command, and as automobile builders acquaint themselves more fully with the indispensable conditions of economical industrial transportation.

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* Under similar conditions the limits of economy in horse haulage, as compared with the railway at the three tariffs mentioned, lie at 12, 19, and 34 kilometres.

THE STORES METHODS OF THE POND MACHINE-TOOL WORKS.

By Horace Lucian Arnold.

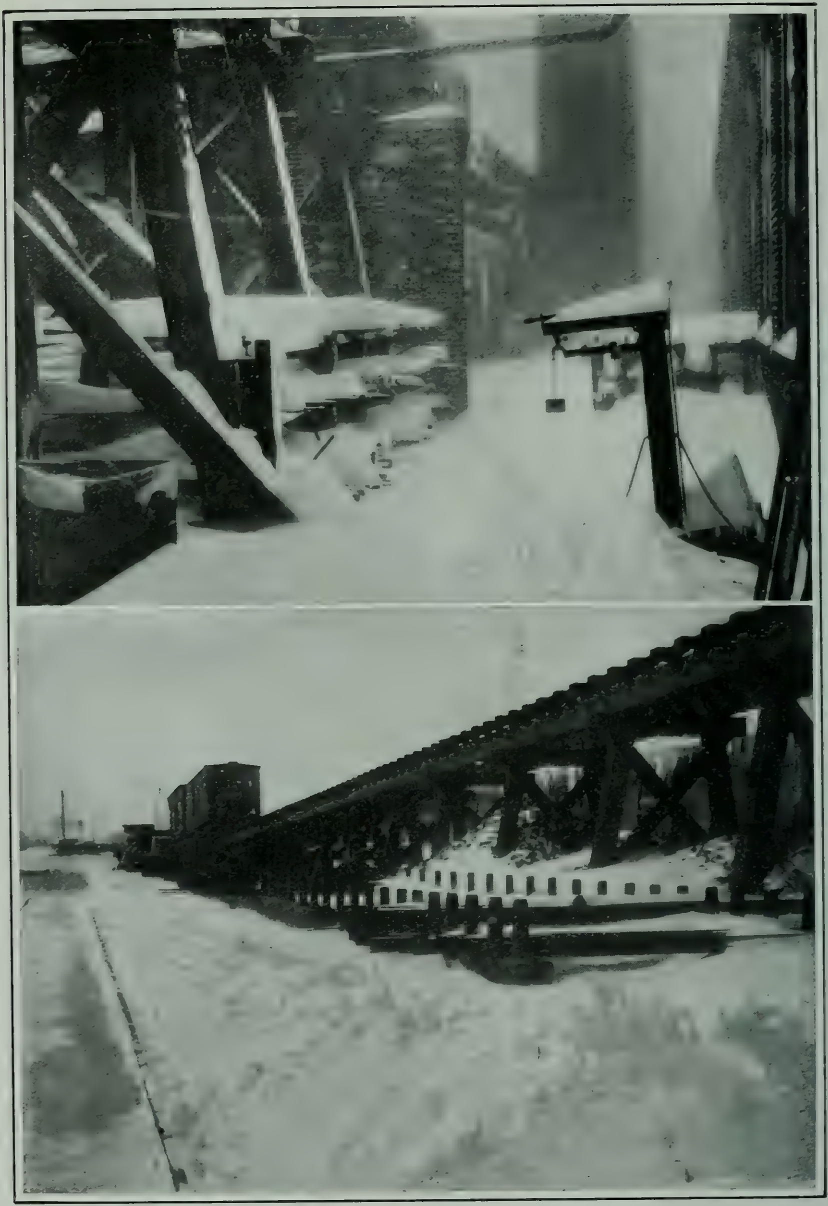
The stores department is generally acknowledged among shop managers to be that upon which the least satisfactory conclusions have been reached in the matter of reorganization and modernization. With a hope of leading in the formation of a better practice and a fuller literature in this field, as we have had the privilege of doing in the field of cost keeping, THE ENGINEERING MAGAZINE has undertaken the publication of a series of articles descriptive of the working methods of a number of shops. The first of the group appears below. The Pond shops are selected for their known and established success. Their stores system represents the result of gradual growth and expansion, with successive expedient adaptations to meet incoming conditions, but with no radical attack upon the problem of devising a system for a large shop. THE EDITORS.

THE Pond machine shop, in which the rough-stores room and the finished-stores room are included, is 1,007 feet long by 100 feet wide. The rough-stores room is at the extreme western end, and the finished-stores room at the extreme eastern end of the machine shop, which does not stand exactly east and west.

The rough-stores room occupies the northwest corner, approximately, of the machine-shop floor, taking in about 40-feet square, with racks and bins on the east, and stores-keeper's office and castings floors on the west.

There is a flush 24-ton scale platform, with railway track on it, between the rough-stores office and the racks and bins, and a 3,000-pound platform scale on wheels on the castings floor just north of the office, next the west wall. A small scale on a bracket against the bin frame completes the stores-keeper's weighing outfit, and a small lever shear, two power hack-saws and cutting-off machines, all near the small round-stock rack and bins, complete the stores-keeper's weighing and cutting machinery.

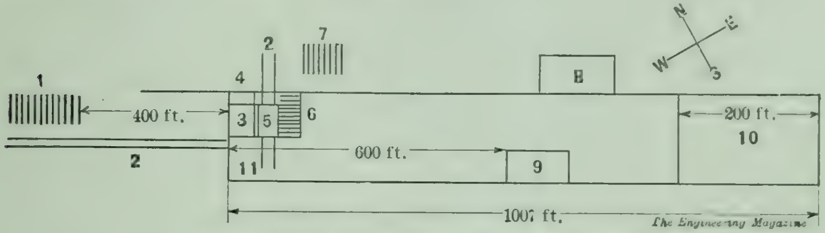
Rough Stores Placing.—Small bars are racked under the second floor of the bins and shelves; this floor is reached by a short flight of stairs. Round and flat iron and steel in medium sizes are racked close to the stores room, out-doors, on the north side of the shop. The small sizes of round machine steel, up to 1½-inches diameter, are racked in the stores room, as shown in illustration. The larger sizes of steel and iron bars are racked out of doors, about 400 feet



OUT-OF-DOOR RACKS FOR IRON AND STEEL BARS.

The set in the lower picture are for heavy bars (space 1 in plan); those in the upper one are for medium and light bars (space 7 in plan). The views, taken after the snowstorm of January 25, suggest some disadvantages of out-door storage.

west of the stores-keeper's office, between a railway track running into the works and an elevated railway trestle, these heavy steel-bars racks being replenished by an Industrial Works locomotive crane, which moves on the railway track as required. The round bars racked outside may run from 50 to 100 tons in quantity, according to the stage of replenishment. This stock is delivered by the railway, and unloaded to the racks by the locomotive crane. A plan sketch of the works is given, which will enable the reader to understand the lines of stores delivery.



SKETCH PLAN OF THE POND MACHINE SHOPS.

1, heavy iron and steel bars, 400 ft. west of rough-stores room; 2, 2, railway tracks into shop; 3, rough-stores keeper's office; 4, castings floor; 5, scale platform, 24 tons; 6, two floors of boxes and light-bars rack; 7, medium-bars racks, out of doors; 8, drawing room; 9, main offices, Head, factory accountant, and finished-stores keeper; 10, finished stores; 11, boxing and shipping.

Rough-Stores-Keeper's Force.—Rough stores are delivered by the rough-stores keeper to the iron foundry, the smithy, the machine shop, and the boxing and shipping floor.

The stores keeper has three clerks and one trucker; several other truckers are used in the foundry and machine shop, some of whom are Africans. One of the clerks is the "record clerk," or stores-keeper's accountant, one is the castings clerk, and one is the forgings clerk.

The record clerk, or store's accountant, records all stores, receipts, and disbursements, except iron castings.

The castings clerk records the receipts of all castings, no matter where made of what material, on Forms 6; the Pond Company operates a large foundry and makes its own iron and semi-steel castings. These are kept in the yard out of doors, when made in advance of shop demands, or are sent directly to the stores keeper, who weighs and charges them to production orders, and delivers them—if small, by truckers; if large, on cars to the traveling cranes. The main floor is covered by four large electric traveling cranes, the south side has two smaller traveling electrics, and the north side, one.

The forgings clerk reports deliveries of iron and steel bars on Forms 8, and makes miscellaneous deliveries, recorded on Forms 7.

FOUNDRY TRUCKMAN, TAKING A LOAD OF CASTINGS FROM ROUGH-STORES CASTINGS CLERK TO MACHINE-SHOP CONSTRUCTOR.

Books Kept by Rough-Stores Keepers.—1. List of shop orders; large bound volume.

2. Stores-record books, separate volumes, filled from Forms 9.

Eight of these are in use, Tengwall binders to take sheets 14 inches long by 10 inches high; Book A records screw disbursements; B, tool and machinery steel bars; C, nuts, washers, steel, iron and fiber, woodruff keys, oil cups, bushings, oil pipes, chains, shear blades, carriage and machine bolts, and lag screws; D, miscellaneous; E, composition castings; F, pig and scrap iron, steel springs, steel plates, steel forgings, cap screws, round and flat iron; G, pipe fittings and pipes, steel castings, and additional screws; H, composition castings, files, drills, taps, and wood-screws. These eight books are made up of Forms 9, stores-record sheets, on which stores disbursements are recorded, charged against their respective order numbers—the "bin number," "sample number," or "piece symbol" being used, as taken from the "sample-number index book" in making all stores disbursements charges on Forms 3A, which are printed the same on both sides. (See illustration, "Form 9."

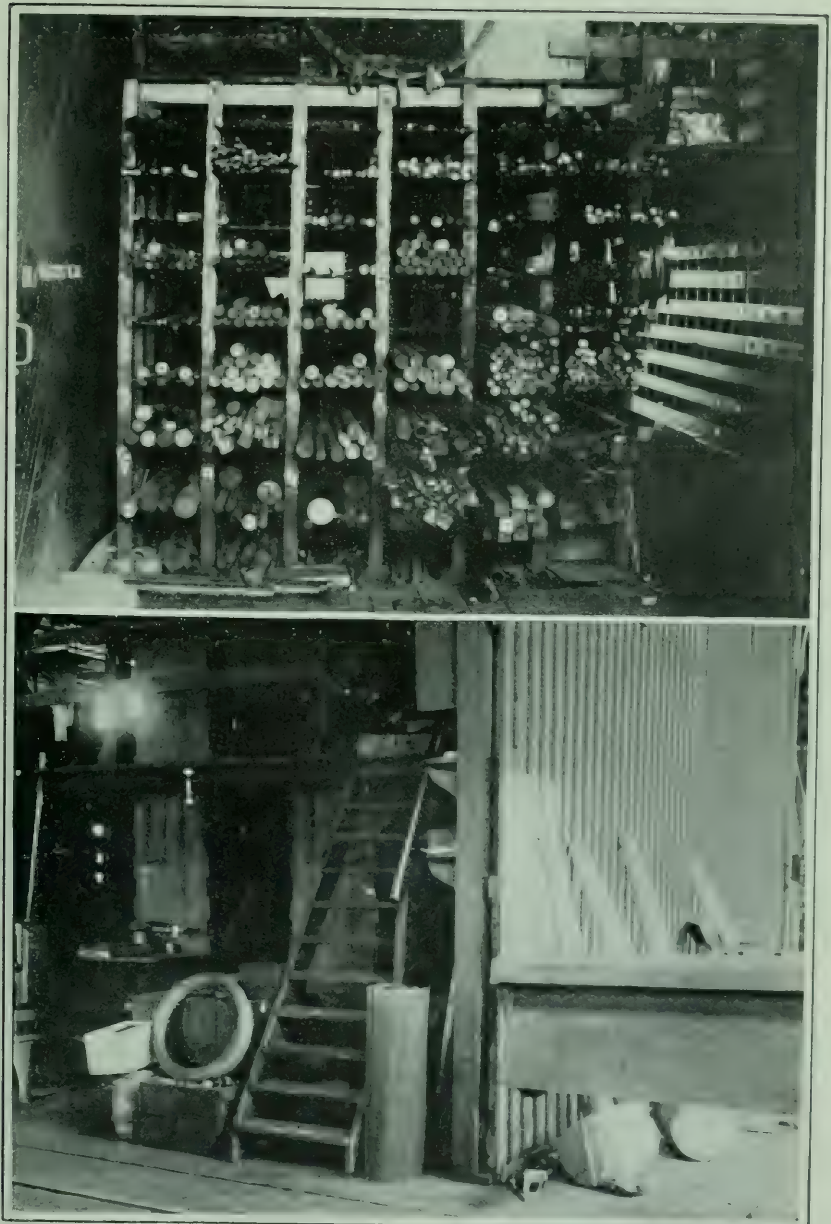
3. Office orders. Letter press copy book, copies of Form 1.

4. Day-book record of rough stores received from all suppliers, factory and outside. Gives the rough-stores keeper a date record, and is his warrant for certifying bills payable to outside suppliers.

5. Letter copy book:

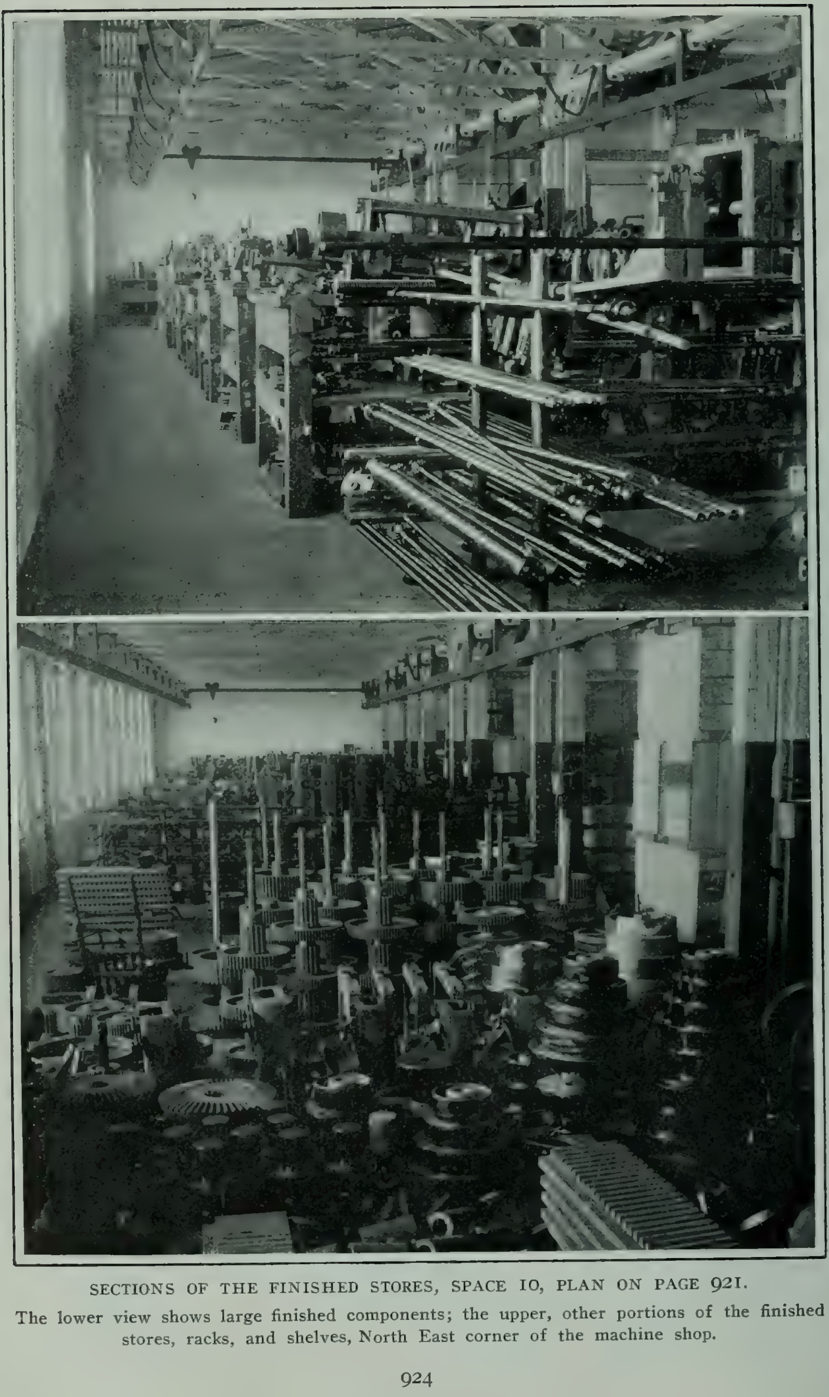
ROUGH-STORES-KEEPER'S DESK.

Space 3 in plan.



DETAILS OF ROUGH STORES, SPACE 6 IN PLAN ON PAGE 921.

The floor in the lower picture is the platform of the scales. The stairs lead to the top bins. This is the entrance to the rough stores from the machine shop. The upper picture shows light bars racked under the top-floor bins.



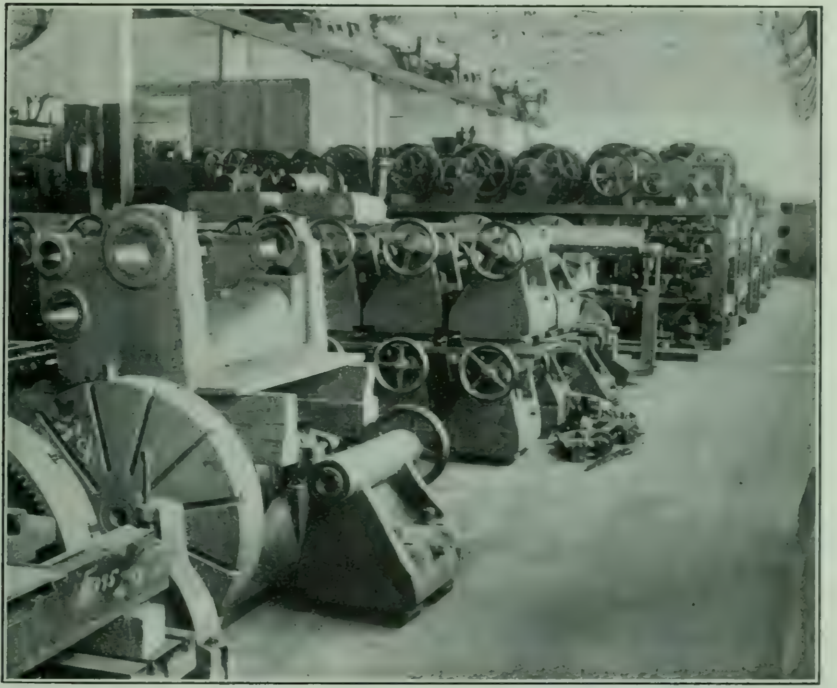
SECTIONS OF THE FINISHED STORES, SPACE 10, PLAN ON PAGE 921.

The lower view shows large finished components; the upper, other portions of the finished stores, racks, and shelves, North East corner of the machine shop.

letters to hurry outside supplies, written on regular letter heads.

6. Drayman's receipts, stub book, Form 11.

Bin Numbers.—The rough-stores room has about 1,500 separate bins, of which about 900 have individual consecutive numbers, known as "sample" numbers. Each "sample number" designates a particular component, as "Sample 376," which is a square-head cap screw, 5 inches long by 1⅛ inches diameter.



FINISHED STORES (SOUTH SIDE OF SPACE 10, IN PLAN).

Sample-Number Index Book.—This is a scrap-book 6½ inches high by 4 inches wide, made up of small blue-print sheets of small-scale drawings and size specifications of screws, nuts, washers, keys, and pins. Duplicate copies of this "index book" are kept in the drawing room, and many of the foremen also have copies. "Sample-number" would legitimately translate into "piece (or part) symbol," and when written calls for a certain kind of a piece of fixed dimensions. "Sample numbers" and "bin numbers" are two terms for the same thing. A "bin number" is a "sample number" painted on a card and the card nailed on the bin containing the article specified.

The "Order-Number Stores-Room Requisition."—When the drawings for an "order"—that is, a production—are completed, two or three "supply-sheet" tracings are made, one each for castings, forgings, and stores supplies; or, where there are only a few parts, "forgings" and "stores supplies" are combined on one sheet of tracing. Blue prints from these supply-sheet tracings go to the rough-stores room, the construction foreman, and the factory accountant.

"Stock"-Record Sheets or Stores-Record Sheets.—"Stock" and "stock-room" are used at the Pond shops for stores and stores room. The title of this form is properly "stores-disbursement charges." The title here used is "stores record."

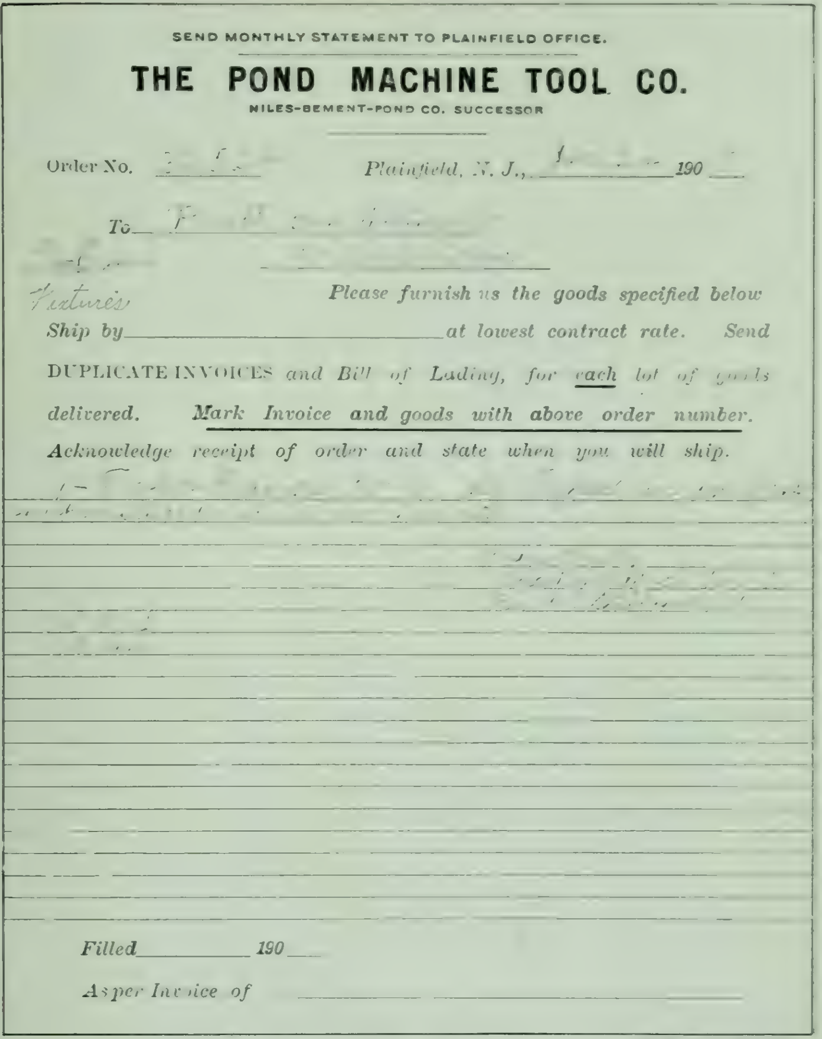
Rough-Stores Replenishments.—The rough-stores keeper is also the purchase agent, and the finished-stores keeper is also the shipping clerk. The tool-room foreman is made the tool-steel-bars and rods keeper.

All rough-stores replenishments are made by orders to suppliers, filled by the rough "stores keeper, acting as purchase agent, on Forms 1, which see.

Form 1 is the only purchase form used by the Pond Machine Co., and is filled for purchases of all replenishments and supplies, of every description. These forms are kept by the general stenographer in the main office. About 3 p. m. each day this stenographer reports at the rough-stores-keeper's office, about 600 feet from the stenographer's office, and writes the stores-keeper's orders for the day in short-hand; he then takes them to his own office, 600 feet return, and there fills Forms 1 to satisfy the rough-stores-keeper's requisitions, one copy only for each supplier for the same order date. "S. O." stands for "shop order," meaning "production order," and in case the requisition is to be charged directly and solely to a single S. O., this S. O. number follows the specification line, as, in the case of Form 1, filled to a supplier of steel-castings, "B2-24-Steel Castings, P-26427-S. O. 28552." "B2-4-Steel Castings, P-26426-S. O. 28734," P. 26427 and P. 26426 being pattern numbers.

On the day of filling the stenographer sends the order to the Head, in this case Mr. Stebbins, who vises the order and vivifies it by adding his signature.

Foundry rough-stores are commonly placed in charge of the foundry superintendent. The Pond procedure is as follows, the rough-stores keeper acting as purchase agent and delivering his foundry-supply purchases in bulk directly to the foundry superintendent.



SEND MONTHLY STATEMENT TO PLAINFIELD OFFICE.

THE POND MACHINE TOOL CO.

NILES-BEMENT-POND CO. SUCCESSOR

Order No. ______ *Plainfield, N. J.,* ______ *190*__

To ______

Fixtures

Please furnish us the goods specified below

Ship by ______ *at lowest contract rate. Send* DUPLICATE INVOICES *and Bill of Lading, for each lot of goods delivered. Mark Invoice and goods with above order number. Acknowledge receipt of order and state when you will ship.*

Filled ______ *190*__

As per Invoice of ______

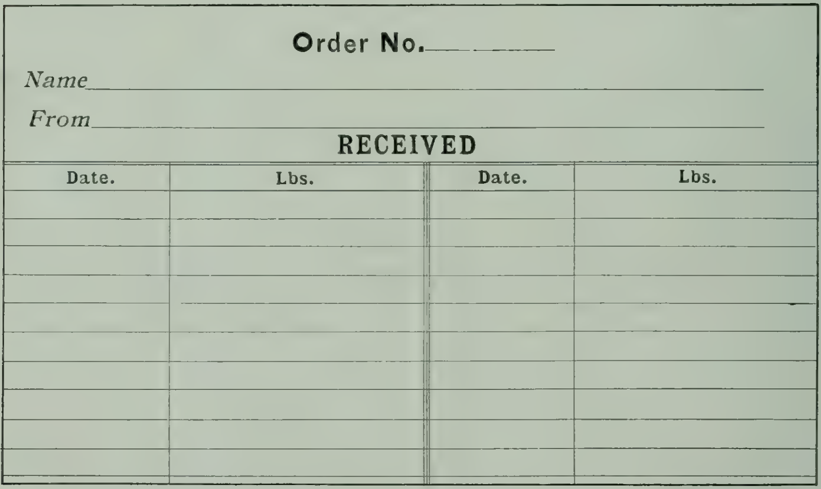
The Engineering Magazine

FORM I, ROUGH STORES. ORDER TO SUPPLIER.

Printed in copying ink, on white paper; 8½ by 11 inches.

Foundry Rough Stores.—Foundry replenishments are made by the rough stores-keeper's dictation to the office stenographer (See Form 1, caption). Sand, facing, flour, nails, brushes, rosin, and all minor foundry supplies go directly into the keeping of the foundry superintendent and are charged in the lump to the foundry expense, and disbursed by the foundry superintendent to workmen with no check or memorandum. Foundry fuel is treated in the same manner, the coal, coke, and wood being charged to expense and delivered to the foundry superintendent, who keeps individual heat and cupola accounts of fuel used and metals charged. The rough-stores keeper weighs the loaded coal cars as received, on a track scale located about 500 feet west of the machine shop, and weighs the empty cars after unloading, crediting the difference in weights to the supplier.

The foundry metal supplies, pig and scrap iron, are purchased on the superintendent's requisition on the rough-stores keeper, using Form 2, and when received are piled near the foundry, where they are subject to the superintendent's order to the melter; the original memorandum of the melter's daily charging weights and materials is sent to the works accountant through the rough-stores-keeper's office, where a memorandum is made of the pounds of pig iron and pounds of scrap used for the day, with no reference to order numbers. A separate account is kept with each cupola, on form blanks 4 which see, with caption.



Order No.__________

*Name*____

*From*____

RECEIVED

Date.	Lbs.	Date.	Lbs.

The Engineering Magazine

FORM 2, ROUGH-STORES-KEEPER'S RECEIPT FOR FOUNDRY-SUPPLY METALS. Stiff manila card, 6 in. square; ruled in red and printed in black. Form 3 is precisely similar, except that the word "Received" is replaced by "Taken Out."

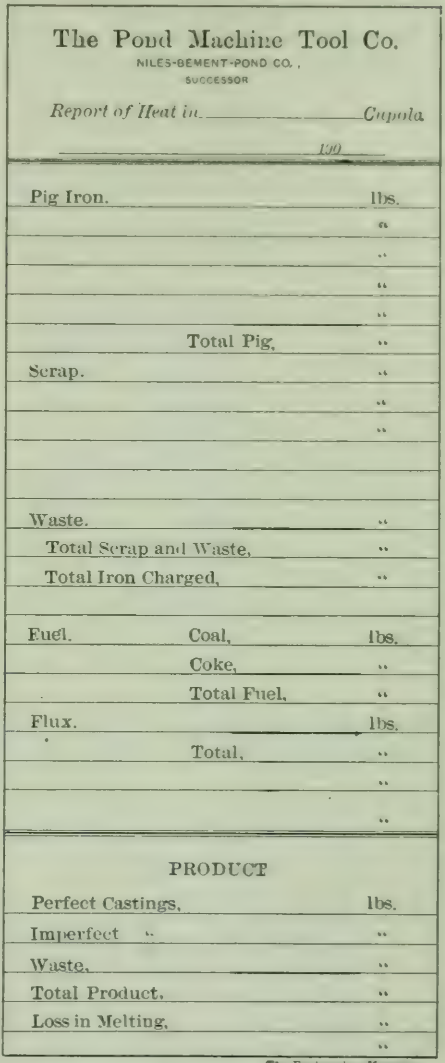
Form 2 is the rough-stores keeper's receipt for foundry-supply metals only—pig and scrap irons, received from suppliers in response to orders made on Form 1.

Form 3 is used to record the melter's daily requisitions for each cupola in blast. Forms 2 and 3 are tacked one on each side of a thin board, same size, and this "target" is kept in a covered box fixed adjacent to any out-of-doors pile of pig iron, or scrap, foundry stores. Form 2 is filled by the rough-stores keeper when material is added to stores on hand, the previous Form 2 being removed from the target and sent to the factory accountant.

Form 3 is nailed to the target blank, when a new Form 2 is fixed to the target. Forms 3 are filled daily by the foundry clerk to satisfy the melter's requisitions. Forms 2 and 3 are removed together and sent to the factory accountant upon receipt of a pig-iron or scrap-iron replenishment.

The individual cupola charges and productions are recorded on Forms 4.

The daily memorandum of castings is filled in by the castings clerk on Form 5, delivered to the stores keeper, and held in the stores room as long as it is useful. Form 6 is filled out from the daily records of Form 5, and serves to fix the date of the receipt, by the stores room, of individual components—often an important matter. Form 7 is the stores-room delivery-clerk's component charge sheet against production-order numbers, filled out by him from Forms A9 and B9, valued by the stores-room accountant, and sent in daily to the factory accountant. Form 8 is similar, but applied



The Pond Machine Tool Co.
NILES-BEMENT-POND CO.,
SUCCESSOR

Report of Heat in ________ *Cupola*

________ *190* ____

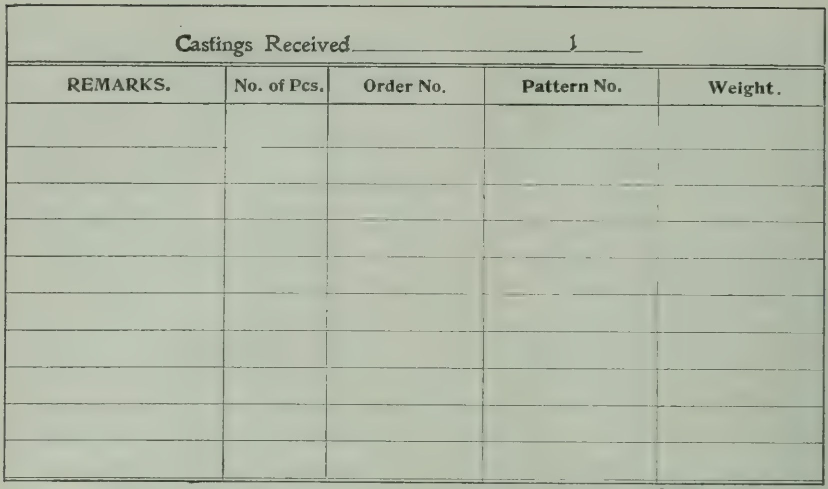
Pig Iron.		lbs.
		"
		"
		"
		"
	Total Pig,	"
Scrap.		"
		"
		"
Waste.		"
Total Scrap and Waste,		"
Total Iron Charged,		"
Fuel.	Coal,	lbs.
	Coke,	"
	Total Fuel,	"
Flux.		lbs.
	Total,	"
		"
		"

PRODUCT

Perfect Castings,	lbs.
Imperfect "	"
Waste,	"
Total Product,	"
Loss in Melting,	"
	"

The Engineering Magazine

FORM 4. INDIVIDUAL CUPOLA RECORD.
Filled from the melter's reports by the foundry clerk, and sent by him to the rough-stores keeper, one day late. Kept until castings clerk can weigh the castings produced and so fill the credit spaces under "Product"; then sent to factory accountant. Form is 4 by 11 in., white paper.



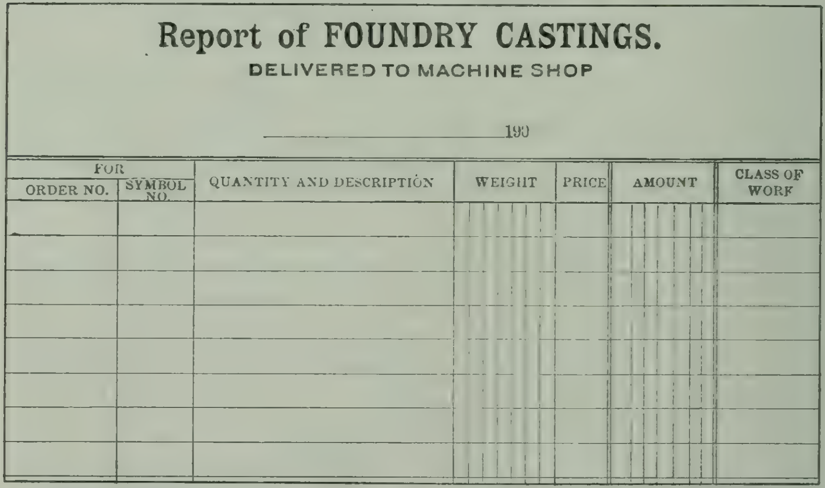
Castings Received ______________ 1 ______

REMARKS.	No. of Pcs.	Order No.	Pattern No.	Weight.

The Engineering Magazine

FORM 5. STORES-KEEPER'S DAILY MEMORANDUM OF CASTINGS RECEIVED.

Filled by castings clerk, and held by stores room as long as useful. Supplies the data for Form 6. 8¼ in. wide by 10 in. high, white paper, blocked in pads.



Report of FOUNDRY CASTINGS.

DELIVERED TO MACHINE SHOP

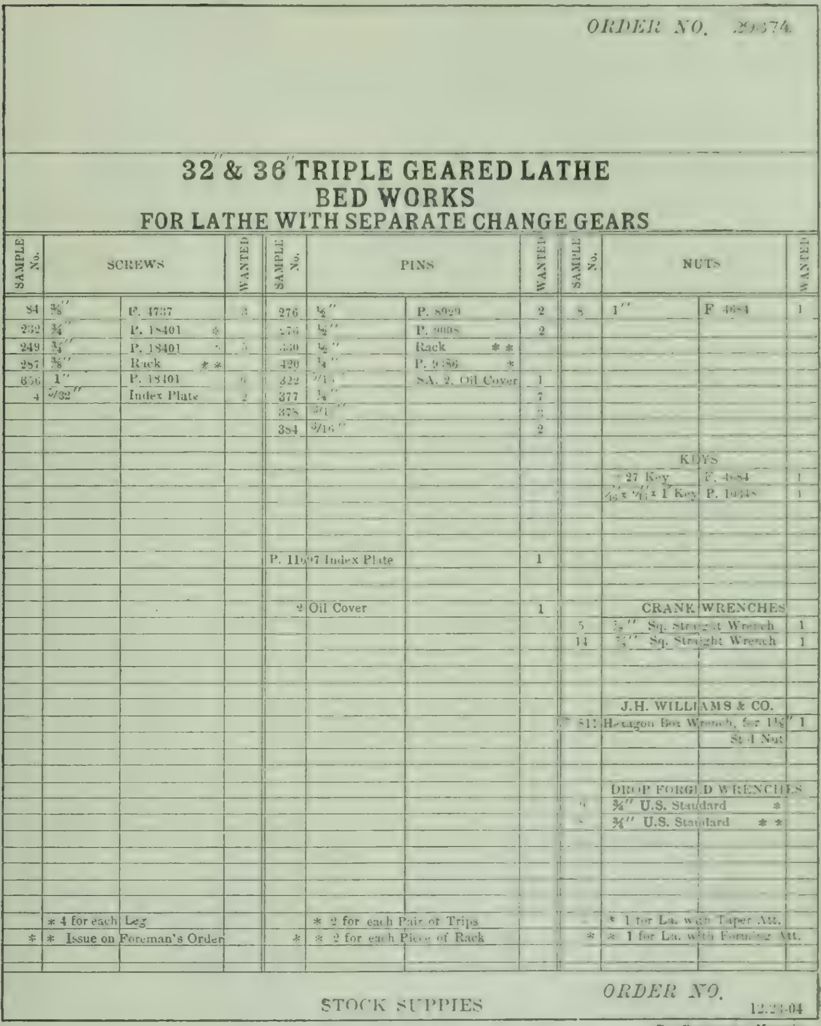
______________ 190

FOR		QUANTITY AND DESCRIPTION	WEIGHT	PRICE	AMOUNT	CLASS OF WORK
ORDER NO.	SYMBOL NO.					

The Engineering Magazine

FORM 6. INDIVIDUAL CASTINGS-COMPONENT CHARGE RECORD AGAINST PRODUCTION-ORDER NUMBERS.

Filled by rough-stores castings clerk as castings are sent to constructing or erecting foremen, and sent daily by stores keeper to factory accountant. Manila paper, 8½ in. high by 13 in. wide. The cut shows the column headings and mode of ruling, in reduced scale. Forms 7 and 8 are identical in every way, except the former is headed "Store-Room Report of Miscellaneous Material and Supplies Delivered to Machine Shop," and the latter "Store-Room Report of Bar Iron and Steel Delivered to Machine Shop"; these are filled by the stores-room delivery clerk from Forms A9 and B9, examined and valued by the stores-room accountant, and by him sent in daily, with values fixed in detail, to the factory accountant.



ORDER NO. 29374

32" & 36" TRIPLE GEARED LATHE
BED WORKS
FOR LATHE WITH SEPARATE CHANGE GEARS

SAMPLE No.	SCREWS		WANTED	SAMPLE No.	PINS		WANTED	SAMPLE No.	NUTS		WANTED
84	3/8"	F. 4737	3	276	1/2"	P. 8929	2	8	1"	F 4684	1
232	3/4"	P. 18401 *		276	1/2"	P. 9008	2				
249	3/4"	P. 18401 *	5	330	1/2"	Rack * *					
257	3/8"	Rack * *		420	1/4"	P. 9386 *					
836	1"	P. 18401	6	322	3/4"	SA. 2. Oil Cover	1				
4	5/32"	Index Plate	2	377	1/4"		7				
				378	3/4"		3				
				384	3/16"		2				
									KEYS		
									27 Key	F. 4684	1
									3/16 x 3/4 x 1" Key	P. 10348	1
				P. 11697 Index Plate			1				
				2	Oil Cover		1				
									CRANK	WRENCHES	
								5	3/8" Sq. Straight Wrench		1
								14	7/8" Sq. Straight Wrench		1
									J.H. WILLIAMS & CO.		
								512	Hexagon Box Wrench, for 1 1/8"		1
										Std Nut	
									DROP FORGED WRENCHES		
								9	3/4" U.S. Standard *		
								8	3/4" U.S. Standard * *		
	* 4 for each	Leg			* 2 for each Pair of Trips				* 1 for La. with Taper Att.		
*	* Issue on	Foreman's Order		*	* 2 for each Piece of Rack			*	* 1 for La. with Forming Att.		

STOCK SUPPIES

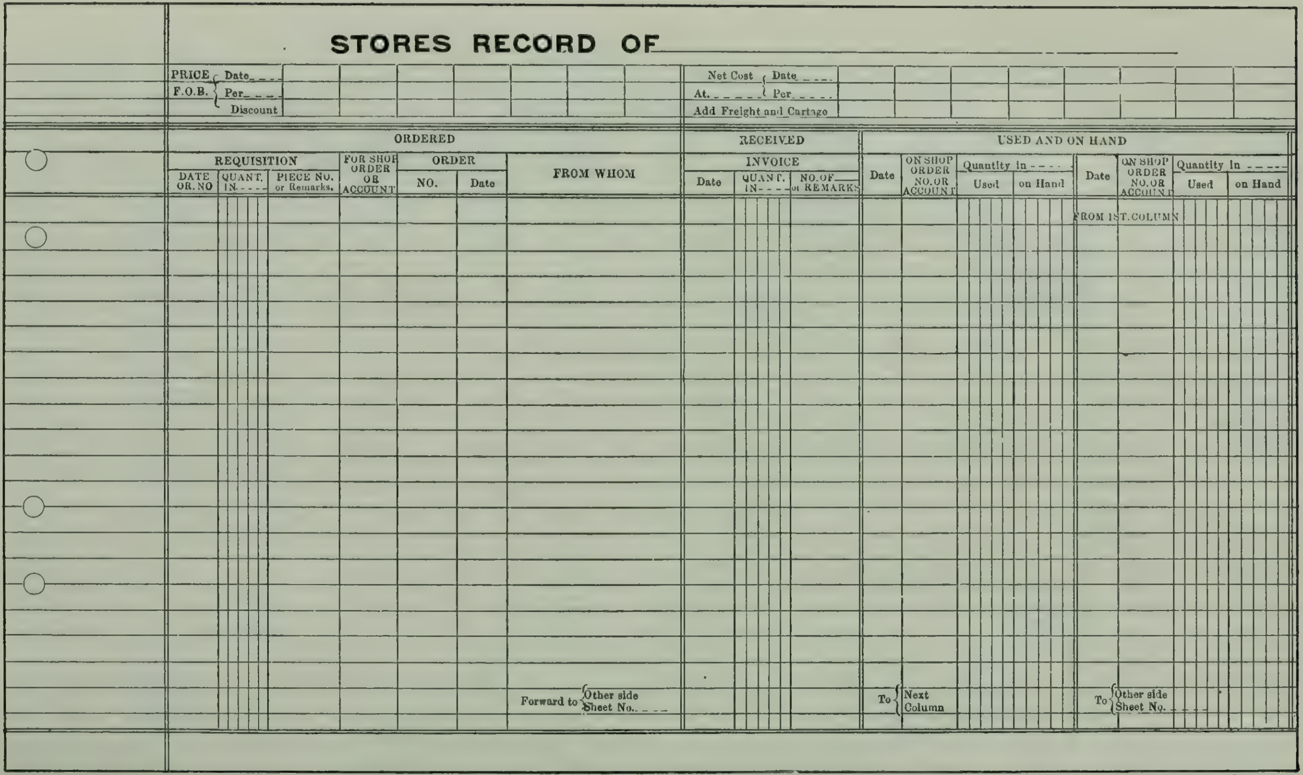
ORDER NO. 12-23-04

The Engineering Magazine

FORM A 9. DRAWING-ROOM REQUISITION.

Blue print, 10 by 12 in. The printed text on this reproduction of course appears as draughtsman's lettering on the original. Sent to rough-stores keeper, copied by him into his "shop orders" book, and sent to the stores accountant by whom it is used in filling Form 9, upon which the items are separated into related groups.

to forgings or bars, instead of castings. Forms A9 are made in the drawing room, together with a sufficient number of separate sheets of the same size (blue prints) specifying castings and forgings components for the same production-order number. Forms A9 are sent



STORES RECORD OF ____________________

PRICE F.O.B. { Date ---- Per ---- Discount

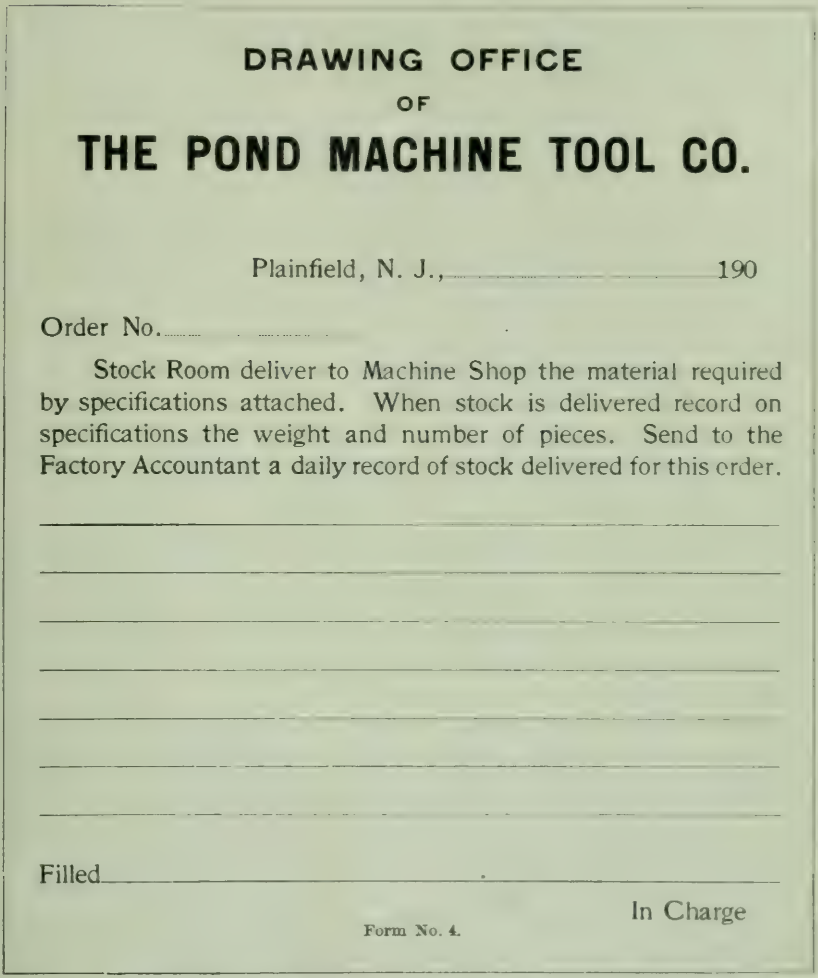
Net Cost At. ------ { Date ---- Per ---- Add Freight and Cartage

	ORDERED							RECEIVED			USED AND ON HAND							
	REQUISITION			FOR SHOP ORDER OR ACCOUNT	ORDER		FROM WHOM	INVOICE			Date	ON SHOP ORDER NO. OR ACCOUNT	Quantity in ----		Date	ON SHOP ORDER NO. OR ACCOUNT	Quantity in ----	
	DATE OR. NO	QUANT. IN----	PIECE NO. or Remarks.		NO.	Date		Date	QUANT. IN----	NO. OF---- or REMARKS			Used	on Hand			Used	on Hand
															FROM 1ST. COLUMN			
							Forward to { Other side Sheet No. ----				To { Next Column				To { Other side Sheet No. ----			

The Engineering-Magazine

FORM 9. STORES RECORD OF STORES DISBURSED TO INDIVIDUAL PRODUCTION ORDERS.

Filled by the rough-stores-keeper's accountant from Forms A9, related components for the same order being kept on the same sheet so far as possible. Finally bound in Tengwall binders. The right-hand column gives the component inventory at the date of insertion of the last sheet.



DRAWING OFFICE
OF
THE POND MACHINE TOOL CO.

Plainfield, N. J., ______________ 190

Order No. ______________

Stock Room deliver to Machine Shop the material required by specifications attached. When stock is delivered record on specifications the weight and number of pieces. Send to the Factory Accountant a daily record of stock delivered for this order.

Filled ______________

In Charge

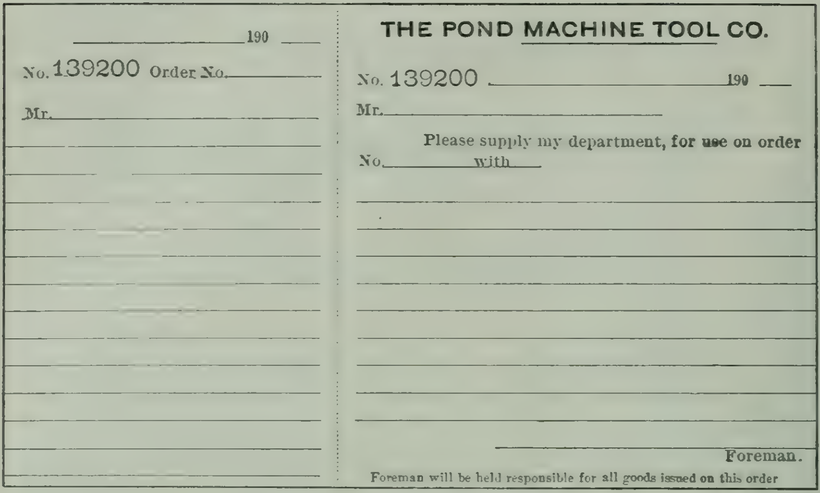
Form No. 4.

FORM B 9. PRODUCTION-ORDER COMPONENT-CHARGE INSTRUCTIONS FROM DRAWING-ROOM TO STORES KEEPER.

Filled by drawing room, sent to stores keeper, by him satisfied and sent to factory accountant. Green paper, 8 in. wide by 5½ in. high.

to the rough-stores keeper, and the specific titles are copied into the "shop-orders" bound book, by him; this book is simply his sequence memorandum of production-order numbers, for his reference only, with no values recorded.

Forms A9 are given by the rough-stores keeper to the stores accountant, who fills Forms 9 from Forms A9, separating the items into related groups on Forms 9, which are afterward made into sepa-



190

No. 139200 Order No.

Mr.

THE POND MACHINE TOOL CO.

No. 139200 190

Mr.

Please supply my department, for use on order No. with

Foreman.

Foreman will be held responsible for all goods issued on this order

FORM 10. "THE RED ORDER."

Numbered consecutively, and bound in stub books of 500 each, 5½ by 10 in. over all, the order being 6 and the stub 4 in. wide. Filled by any foreman and satisfied by rough-stores keeper.

rate volumes in Tengwall binders, each component having a bin-inventory column at extreme right, verified by actual semi-yearly count and survey.

Forms A9 are next given to the stores-keeper's delivery clerk, who satisfies them with deliveries from stores to the construction foreman having the production order in hand.

Form A9 has Form B9 pinned to it when sent from the drawing room to the stores room.

For minor orders Form B9 is used alone, without Forms A9, or 9, is satisfied by the stores keeper, and sent to factory accountant. Larger orders or orders requiring more detailed information, are pinned to Forms A9, and the two are sent, fastened together, to the stores keeper.

Form 10 is known in the Pond shops as the "red order"; it is filled by any foreman and is either satisfied on presentation to the rough-stores keeper by immediate delivery of the requisition, or at his option is sent to the Head for his approving signature. If the requisition is not in stores, Form 1 is filled to procure the satisfaction. Form 10 is made to bridge all the gaps in the Pond factory requisition procedure, and is used for replacements of components missing after supposed delivery to a construction foreman, for incidental forgings, and by the tool-room foreman for all forgings or castings or other material needed to fill a general small construction order from the drawing room, issued and vitalized by the chief draftsman, as for example:—"The following work to be done and returns made to factory accountant of time on same;

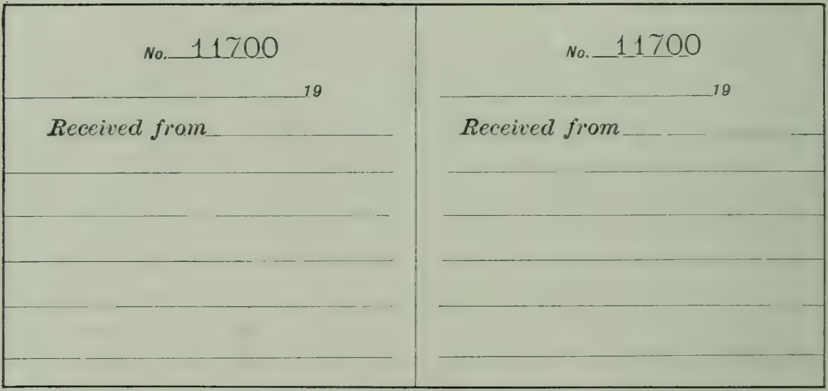
12 Counterbores, Sa. 334.
(Signed) Geo. E. Greenleaf.
Send to Mr. Newman."

Mr. Newman, foreman of the tool room, would fill a Form 10 blank and present it to the rough-stores keeper to obtain material—or, in case the tool-room foreman desired a new machine tool, the same Form 10 would be filled and transmitted to the rough-stores keeper; in this case the Form 10 would go to the Head for his vivifying signature.

The Pond tool room is divided into two departments, located in a single enclosure, but having two heads, of equal rank, the foreman of the tool-room, and the foreman of the tool-makers. The foreman of the tool-room keeps up the supply of all cutting tools produced by forging, tempering, and grinding only, and also keeps up the supplies of files, emery, emery paper and cloth, and repairs on taps, dies, and arbors. Where machine work is required the foreman of the tool-room notifies the foreman of tool-makers, by word of mouth or by a written communication, and the foreman of the tool-makers then fills Forms 10 to satisfy. In case of lathe and planer forged tools, the foreman of the tool-room fills Forms 10 for tool steel needed, which forms are satisfied by the rough-stores keeper, the tool-steel bars being delivered to a private locked tool-steel store and the key held by the tool-room foreman, who issues forging orders on "yellow" forms, not shown here, and presents them with needed tool-steel bars to the tool-smith.

File replenishments are made by requisitions on Forms 10, sent to the rough-stores keeper. Taps, dies and reamers, new, are bought from outside suppliers, the repairs only being made in the tool room, Requisitions for replacement are made on Forms 10.

Form 11 completes the list of form blanks used by the rough-stores keeper. As will be noted, the rough-stores business is transacted in long-hand, some entries being twice written. The system in use has grown up from next to no system at the beginning, forms which seemed to meet imperative requirements being added from time to time. Cards are not used at all, and there is no check on the tool-steel-bars keeper. Medium and large iron and steel bars are racked outside the shop. The rough-stores keeper's office is enclosed, is small, and is crowded. The rough-stores racks and bins are all unenclosed, standing open to access by workmen from the main floor. The bins are on two floors, are poorly lighted, and have electric bulbs between the banks of bins. Originally each bin had a "sample" of its contents fastened outside; this is not now invariably the case, numbers being used, but the word "sample" is still retained in the Pond rough stores phraseology. The rough-stores room is about 600 feet from the drawing room, and from the factory accountant's and finished-stores keepers' desks. The drawing room, finished-stores keeper, factory accountant, and rough-stores keeper communicate often, leading to many miles of travel on foot daily.



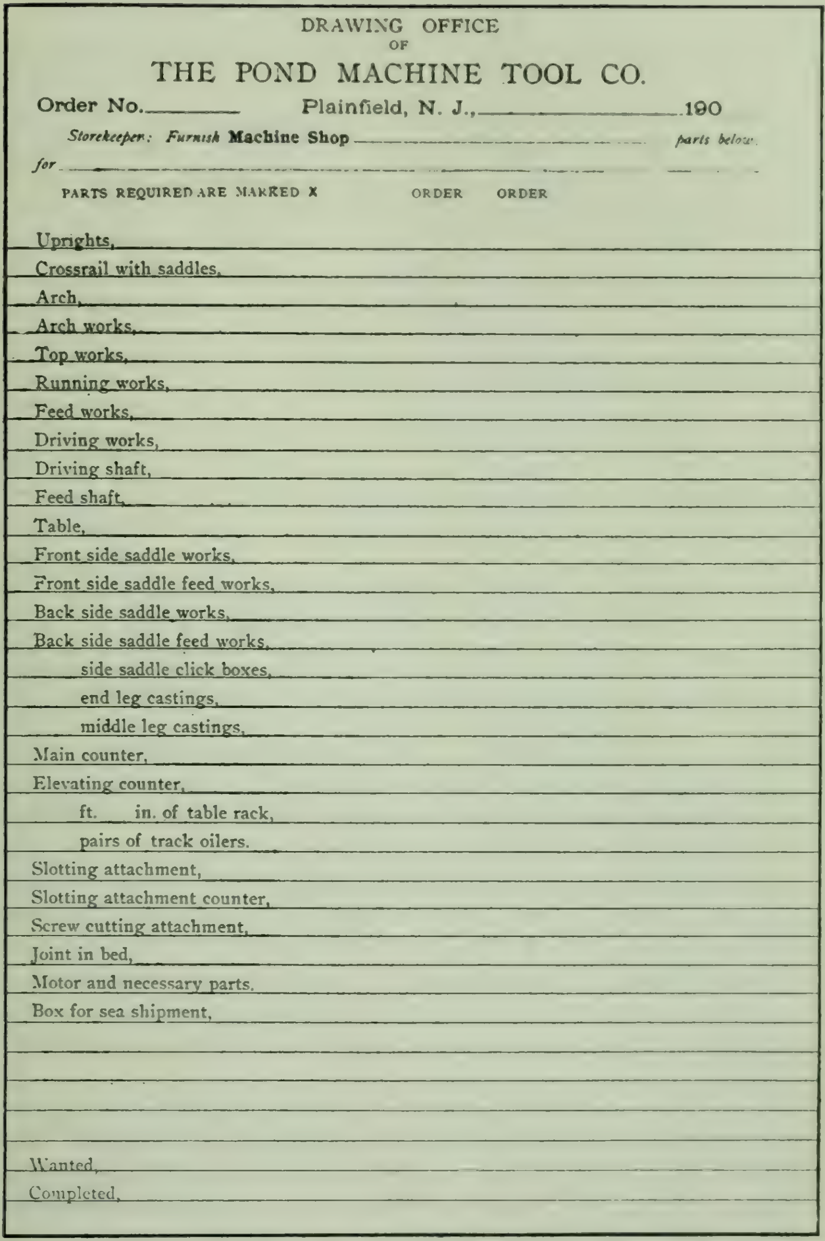
No. 11700	No. 11700
______ 19	______ 19
Received from ______	*Received from* ______

The Engineering Magazine

FORM II. ROUGH-STORES-KEEPER'S DRAYMAN'S RECEIPT.

Stub book, 3½ by 8 in., consecutively numbered; thin yellow paper. Used for draymen's deliveries to rough stores only.

The Pond Finished Stores.—These are kept on about 200 feet of the machine-shop floor, at the easterly end, unseparated from the machine shop, and are in charge of a finished-stores keeper (who is also the shipping clerk) and one helper. The Pond finished stores are received wholly from the machine shop, and are composed of completed machines and components of production orders in progress. The finished stores have no separate books and no placement list is made. The parts are large, and though pieces may remain in store for years, all parts belonging to one order number are placed as close together as may be, and no inconvenience results. Stout shelving is racked in several rows across the easterly end, and there are some iron cross-arm racks next the shelving, for long slender pieces, screws, rods, and the like. Then comes a long floor



DRAWING OFFICE
OF
THE POND MACHINE TOOL CO.

Order No.________ Plainfield, N. J.,____________________190

Storekeeper: Furnish **Machine Shop** ______________________________ *parts below.*

for ____

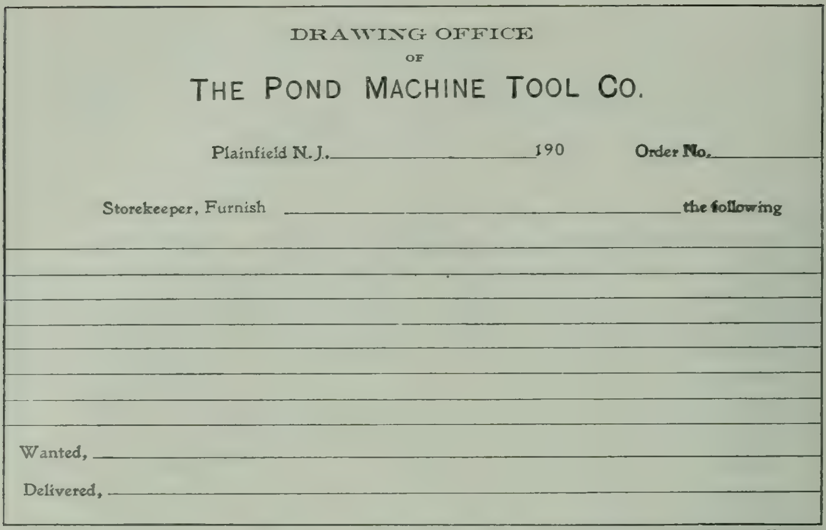
PARTS REQUIRED ARE MARKED X ORDER ORDER

Uprights,
Crossrail with saddles,
Arch,
Arch works,
Top works,
Running works,
Feed works,
Driving works,
Driving shaft,
Feed shaft,
Table,
Front side saddle works,
Front side saddle feed works,
Back side saddle works,
Back side saddle feed works,
side saddle click boxes,
end leg castings,
middle leg castings,
Main counter,
Elevating counter,
ft. in. of table rack,
pairs of track oilers.
Slotting attachment,
Slotting attachment counter,
Screw cutting attachment,
Joint in bed,
Motor and necessary parts.
Box for sea shipment,

Wanted,
Completed,

FORM I, FINISHED STORES. DISBURSEMENT TO FACTORY CONSTRUCTOR.

Filled by the drawing office, and sent for satisfaction to finished-stores keeper. 7½ in. wide by 11 in. high, white paper. Vertical column rules under the words "order," with a narrow column to the left for the × mark, have been omitted by the engraver.



DRAWING OFFICE
OF
THE POND MACHINE TOOL CO.

Plainfield N. J. ______________ 190 Order No. ________

Storekeeper, Furnish ______________________ the following

Wanted, ______________________

Delivered, ______________________

The Engineering Magazine

FORM 2, FINISHED STORES. REGULAR PRODUCTION SHIPMENT ORDER, USED ALSO FOR REPAIRS OR REPLACEMENTS FROM FINISHED STORES.

Brown paper, 5½ by 8½ in., blocked in pads with white interleaves for carbon copy. Filled in type-writer by the drawing room; original sent to finished-stores keeper and duplicate retained and filed. When satisfied, the order is so marked and dated by the stores keeper and returned to the drawing room.

space of piled components, completed machines and large components standing separately on the floors. The finished stores are covered by the main and side traveling cranes. The boxing is at the westerly end, south of the rough-stores room.

The finished-stores keeper has a desk in the factory-accountant's office, nearly midway of the machine shop, and across the shop from the drawing room.

Finished-stores disbursements are made by the finished-stores keeper to satisfy requisitions made by the drawing-room superintendent only. The finished-stores keeper keeps no books, and keeps and fills four form blanks only.

Form 1, is (1) a finished-stores requisition by the drawing room, filled by the drawing room, sent to the finished-stores keeper, and satisfied by delivery of the specified components to a factory constructor; (2) Form 1 is used as the factory production order, same order number as (1), with specifications added as required.

The "wanted" and "completed" are date lines, are superfluous, and are not filled.

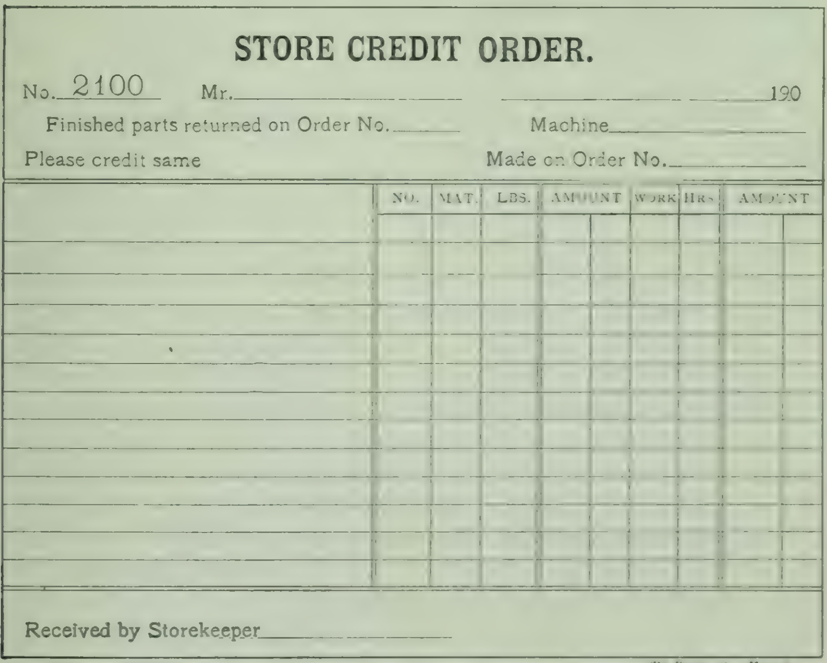
Forms 1, when satisfied, are attached by the finished-stores keeper to the production order, same number, and sent with it to the drawing room.

Form 2 is the regular production shipment order, also used for repairs or replacements from finished stores. It is satisfied by delivery of the specified articles to the shipping clerk, marked delivered, with delivery date, attached to order, and returned with order to the drawing room.

Form 3, finished stores, is filled in manuscript in the drawing room and sent to the finished-stores keeper. It is used where substitutions of production details are made, to return superseded parts to finished stores. It is satisfied by the signature of the finished-stores keeper, and sent to the drawing room.

Of course, though not in this story, all orders and attached documents go from the drawing room to the factory accountant.

This is the one and only form blank used by the finished-stores keeper solely. It is the "waiting" stores receipt, filled and signed



STORE CREDIT ORDER.

No. 2100 Mr.________________ ________________190

Finished parts returned on Order No.______ Machine________________

Please credit same Made on Order No.____________

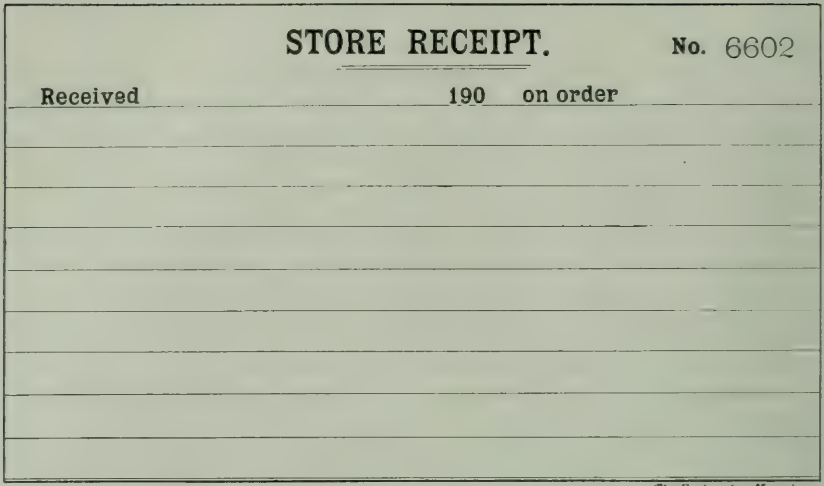
	NO.	MAT.	LBS.	AMOUNT	WORK	HRS.	AMOUNT

Received by Storekeeper________________

The Engineering Magazine

FORM 3, FINISHED STORES. USED FOR SUBSTITUTION OF DETAILS IN PRODUCTION ORDERS.

Filled in manuscript in the drawing room, sent to the finished-stores keeper, satisfied by his signature, and returned to drawing room. Gray paper, 7¾ by 8¾ in.



STORE RECEIPT. No. 6602

Received 190 on order

The Engineering Magazine

FORM 4, FINISHED STORES. "WAITING" STORES RECEIPT.

Numbered consecutively in a stub book; thin yellow paper, 4 by 5½ in. Filled and signed by stores keeper on receipt of finished components waiting assembly or shipment. Pinned to production order and sent to the drawing office on completion of the order.

by the finished-stores keeper on receipt of finished components (commonly from a factory constructor, possibly from rough-stores keeper) which components are to be held by finished-stores keeper until required for assembling in the completed machine or for shipment to a purchaser. The finished-stores keeper is also the shipping clerk. Forms 4 are pinned to the production order and both are sent to the drawing office on completion of order.

The most difficult problem of the long shop is the locating of the offices and the points of entrance for materials and exit for finished product so as to give the shortest lines of official communication and travel, with the fewest handlings and shortest transportations of work in progress. If all the officials are grouped at about the middle of the works, in offices just above the cranes, with rough stores on one side of the principal entrance and exit, and finished stores and the shipping room on its other side, and the drawing room above the offices, with the blue-print and photographic department yet above the drawing room, a good architectural effect is gained by the elevated structure in the middle of the long shed; the drawing room is up out of the dust, the blue-print and photographing rooms are well lighted, and the officials can be placed close to each other and their fields of duty. If supplies come and product goes chiefly by rail or water, it becomes imperative that the materials entrance be crosswise of the shop, and it is also very convenient to have a driveway across the middle of the main floor, under the offices, and a cross-wise corridor on the office floor above the driveway, so as to give straight through travel from the street to the heavy transportation way.

While it is perhaps both desirable and possible to confine official communication mainly to writing, many occasions demand oral communication and face to face interviews between officials, and even with the best arrangements of central telephone office in the reception room added to a constantly traveling messenger service, factory officials often find need for talking personally to each other.

The shortest lines of rough-stores and work-in-progress transportation are had by the midway rough stores and finished stores and shipping room, and all these considerations seem to point to the desirability of the elevated offices located at the middle of the long shop, though this is not the usual arrangement. The factory plan is yet a matter for debate—the cross, the hollow-square, the L and E forms all finding advocates, while a 1904 construction places four factory buildings, one 800-feet long and three each 500-feet long, east and west length, parallel to each other about 100-feet apart, on a flat plot with no rail or water communication established, so that the constructor was free to choose his factory plan.

In the Pond shops the main office and drawing room and finished-stores-keeper's desk are not far apart. The rough-stores keeper and purchase agent is 600 feet away, and the boxing and shipping is 800 feet from finished stores. This arrangement makes long lines of travel for both rough and finished stores and the keepers thereof, who act respectively as purchase agent and shipping clerk in addition to having charge of the stores.

The photographic illustrations were taken during and immediately after a heavy snow-storn, and do not give a favorable impression of out-of-doors racking of bars.

Both rough and finished stores seemed to be well kept, though the rough-stores-keeper's office had not room enough for the storage of the large volumes which must accumulate under the record system employed.

THE SUPERHEATING OF STEAM, AND ITS INFLUENCE ON ENGINE ECONOMY.

By R. Neilson.

I. MODES OF SUPERHEATING, AND TYPICAL FORMS OF CONSTRUCTION.

Mr. Neilson's paper is the first of three dealing comprehensively with the most interesting factors in the economy of the modern steam engine—superheat and vacuum. The current part discusses the various modes of superheating and types of superheaters; the second takes up the effect of superheat on engine efficiency; the third covers the subject of vacuum—forms and operation of condensers and their influence on the economy of the power plant.—The Editors.

SUPERHEATING steam—that is raising its temperature above the boiling point corresponding to its pressure—is by no means a new thing. It was proposed by Joseph Hately in 1768*; and there are several instances of steam being superheated for the purpose of economy prior to 1835. There are, however, difficulties in connection with the production of superheated steam and difficulties in connection with its use in reciprocating engines; and these difficulties, although they were at no time insuperable, have no doubt been the cause of superheated steam not being extensively used until the last few years.

In the production of superheated steam there has been the difficulty of preventing the superheating tubes (for tubes have almost always been used for this purpose) from being at times seriously overheated, and there has been the difficulty of getting from the superheater a constant supply of steam at even approximately uniform temperature. In the use of superheated steam with reciprocating engines there has been the difficulty of lubricating the working parts exposed to the steam, and the difficulty of preventing a fracture in the cylinder or connected parts owing to difference of expansion.

If the demand for steam varies greatly and varies rapidly, and especially of the changes in demand are unforeseen, then, whatever be the method of heating the superheating tubes, there will be great difficulty in always obtaining the same temperature in the steam leaving the superheater, unless some automatic device be used whereby the rate of supply of heat to the steam can be made to vary with the rate of discharge of the steam from the boiler to the engine or engines (by way of the superheater). If a reservoir or receiver could be provided for the steam between the superheater and the engine or engines, so that the flow of steam through the superheater would not vary so greatly as the rate of consumption of steam by the engine or engines, the temperature of the superheated steam could (without any automatic device) be more readily kept approximately constant. The cost of such a reservoir would however be great, and heat radiation losses from it would also be great. The idea therefore seems hardly practicable.

---

* Specification of Patent No. 895 of 1768.

It is of course desirable in almost all cases that the steam should leave the superheater at a constant temperature. This temperature is that which is judged in any particular case to be the best for economy, considering all things. If the temperature of the steam falls below this, the engine, as a rule, will fall off in efficiency; if the temperature rises above this, the engine may be exposed to risk of damage. It is true that some steam engines will stand a very high temperature of steam without any risks being incurred; but, even with these engines, there is bound to be a best temperature, or range of temperature, at which to work, although what this best temperature is may not always be known.

In considering superheating from the point of view of economy to the steam-engine user, it is of course necessary to take into account the depreciation of the superheating plant and the effect of the use of superheated steam on the depreciation of the steam engine, whether that engine be of ordinary construction or specially constructed for use with superheated steam. The risk of accidents which will totally disable the superheating plant or the engine for a long or short period must also be taken into account, not only as regards cost of repairs but as regards possible losses due to stoppage or shortage of power.

The difficulties and dangers connected with the production and use of superheated steam vary greatly with the method adopted for heating the superheater tubes. We may conveniently divide the methods into four classes, as follows:—

Method 1.—Heating by a furnace, independent of the boiler furnace.

Method 2.—Heating by the hot gases (products of combustion, etc.,) passing from the boiler furnace to the chimney.

Method 3.—Heating by the hot gases before these have ceased to act on the boiler.

Method 4.—Heating by a fluid which is itself heated by the hot

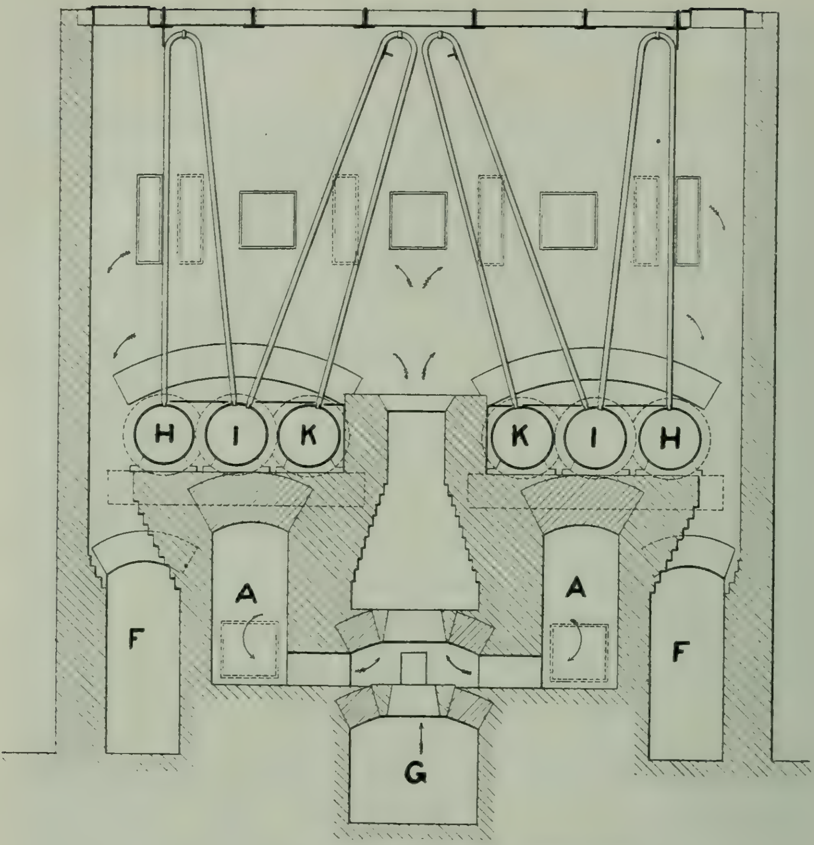


FIG. I. WATKINSON'S GAS-FIRED SUPERHEATER.

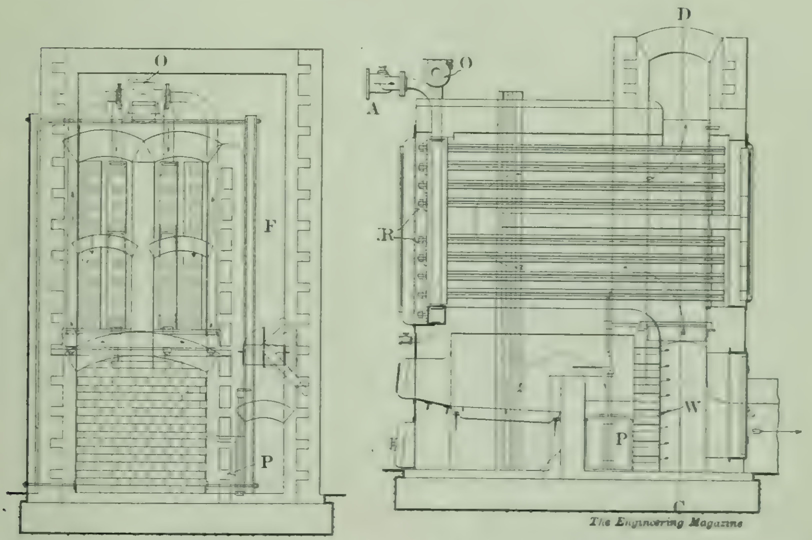
Built by Mechan & Sons, Glasgow, for Colville & Sons' steel works at Motherwell. Capable of dealing with 260,000 lb. of steam per hour. Steam pipes leading to and from the superheater are each 2 ft. diameter.

gases to a higher temperature than the required temperature of the superheated steam.

These methods will now be considered one by one. It should be explained that no attempt is made in this article to describe all the important forms of superheaters; my object is only to exemplify the various methods of superheating.

Method 1. Employing a Furnace Independent of the Boiler Furnace.—By this method the superheater is quite distinct from the boiler and the firing of the boiler does not in any way affect the superheater. An example of this method is given in Figure 1, which shows a Watkinson superheater quite distinct from any boiler and fired with producer gas. The gas enters the superheating chamber from the flues A as shown in the arrows, and is met by air from the gas main G. The products of combustion come into intimate contact with the tubes of the superheater and then leave by the flues F. The steam is arranged to flow in counter-current fashion to the hot gases. The steam is admitted to the outside drums H H and passes through the outer sets of inverted U tubes to the intermediate drum I, and then through the inner sets of U tubes to the drums K from which it is led away to the engine. Prof. Watkinson informs me that since the installation of these superheaters, the rolling-mill engines have been found to run much more rapidly than with saturated steam. Plates which previously took 4½ minutes to roll now take 2½ minutes. This quickness in rolling is of course a very important matter.

In the Watkinson superheater the tubes in each bank are spaced very closely together, with the idea of causing the hot gases to pass through very narrow spaces and thus to deprive them of a great amount of heat at each bank.



The Engineering Magazine

FIGS. 2 AND 3. CROSS SECTION ON LINE C D AND SECTIONAL ELEVATION, BABCOCK AND WILCOX INDEPENDENTLY FIRED SUPERHEATER.

This method of superheating allows of the superheater giving a very uniform supply of heat. As, moreover, the supply of gas and air can be turned on only after there is a sufficient flow of steam through the superheating tubes and the heat supplied to the tubes

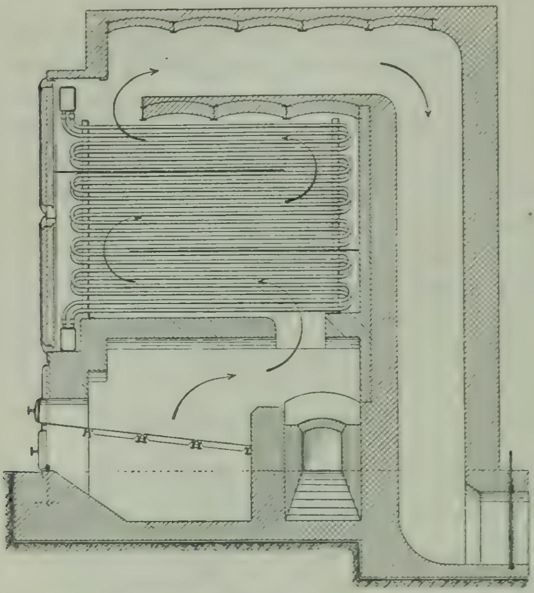


FIG. 4. INDEPENDENTLY FIRED SUPERHEATER, CONSTRUCTED BY THE RHEINISCHE DAMPFKESSEL UND MASCHINENFABRIK BÜTTNER, VERDINGEN A. R.

can to a great extent be regulated with comparative ease, it should not be difficult in most cases to prevent injurious overheating of the tubes and to prevent serious irregularity of the temperature of the steam leaving them, even with great variations in the supply of steam. It is only in a few cases, however, that a supply of producer gas is available. When such a supply is not available, a special furnace must be provided for the superheater. A superheater fired by its own independent coal furnace is illustrated in Figures 2 and 3, which show a construction adopted by Messrs. Babcock & Wilcox. The products of combustion from the grate pass over the bridge B and through the perforated wall W. This wall acts as an accumulator or reservoir of heat. The hot gases then pass upwards among the tubes as shown and down through the side flue F to the chimney. The steam enters at A and is divided into two portions, one passing into each half of the superheater. After passing through the tubes, which are of U shape, the steam is led to the outlet O. It will be seen that the tubes are arranged in sets of four. Caps are provided, one for each four tube ends, these caps being held in place by the small bridges R. A safety valve is placed on the inlet pipe. A by-pass P is provided so that when desired the gases can be shunted direct to the flue F.

Another example of an independently fired superheater is given in Figure 4, which shows a superheater constructed by the Rheinische Dampfkessel und Maschinenfabrik Büttner. In this superheater tubes of considerable length are employed, these being bent into zig-zag fashion as shown and arranged each in a vertical plane.

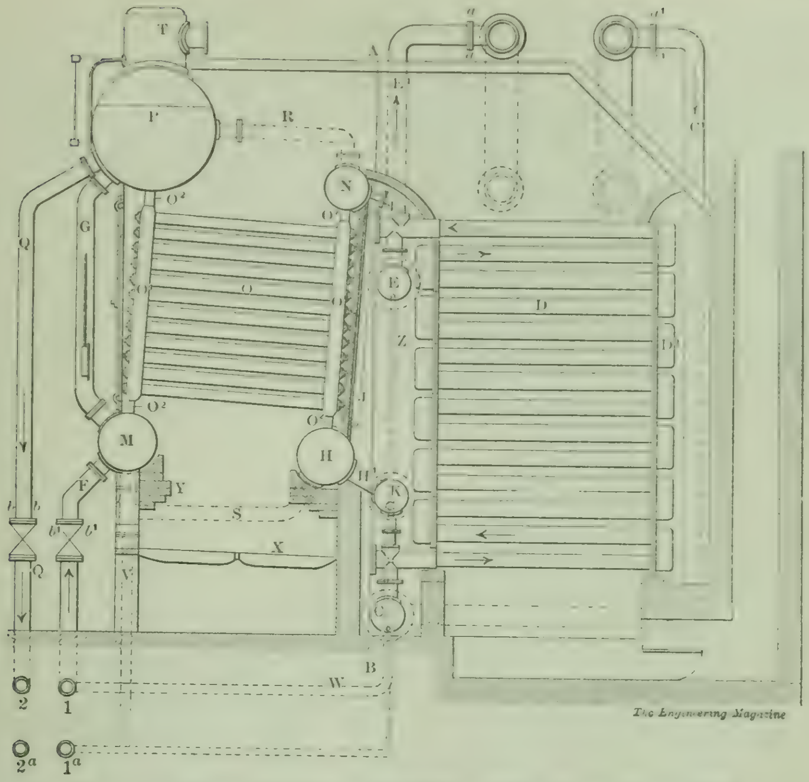


FIG. 5. CRUSE SUPERHEATER COMBINED WITH FEED-WATER HEATER.

A B, vertical section; C, bottom saturated-steam collector; C^1, steam pipes to C; D, steel superheater tubes; E, top superheated-steam collector; E^1, steam pipes from E; F, feed-water supply from main; G, downcomer pipes to bottom drum, M; H, bottom drum (back); H^1, connecting pipes from H to K; J, downcomer pipes from N to H; K, bottom water collector; L, controlling water connecting pipes; M, bottom drum (front); N, top water collector; O, water-heater—4-inch steel tubes, 6⅛-inch pitch; O^1, headers for O, 6 inches square, 6⅛ inches pitch; O^2, connections to drums; P, top drum; Q, hot-water outlet to feed boiler; R, top connection between P and N; S, circulating connections; T, steam drum; V, blow-off and mud tap; W, cold feed for regulating temperature of superheat; X, furnace bars; Y, arch; Z, drain pipes.

By uncoupling any tube from the upper and lower headers, the tube can be removed through the front doors.

When an independent furnace is employed to fire the superheater precautions must be taken to prevent the superheated tubes nearest the fire being seriously overheated. The Cruse Controllable Superheater Company of Salford combine a feed-water heater with a superheater and cause the hot gases to act first on the water tubes so that, when the gases reach the first tubes containing steam, they are at a temperature not above 1,400 degrees F.

Figure 5 shows a construction of superheater designed by this company. O indicates the feed-water tubes which extend nearly horizontally between two headers, the whole feed-water part of the construction being arranged somewhat after the nature of a Babcock & Wilcox marine boiler. The hot gases, after ascending through between the feed-water tubes, pass downwards between the superheating tubes D through which steam passes in counter-current fashion. This combined feed-water heater and superheater is intended to supply hot water to a battery of boilers and to superheat the steam from the same. F is the feed-water supply from the main, and Q is the hot-water outlet to the boilers, C is the saturated-steam collector and E is the superheated-steam collector. The special feature of the Cruse superheater will be referred to later on.

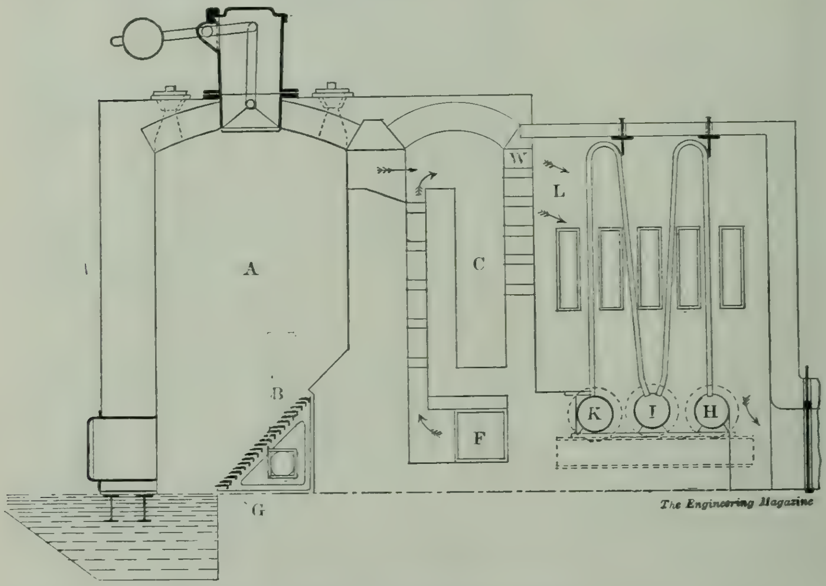


FIG. 6. WATKINSON GAS-FIRED SUPERHEATER PROVIDED WITH ITS OWN GAS PRODUCER.

When an independent furnace is employed to fire the superheater, this, instead of being of the ordinary kind, such as that just described, may be of the producer type. An example of this is given in Figure 6 which shows a Watkinson superheater provided with its own gas producer. A is the producer in which the producer gas is formed, air being drawn through the grate G and steam forced through the blower B. The producer gases pass out of the top of the producer to the chamber C, where they meet with air which enters through the duct F and passes upwards through the brickwork as shown by the arrows. A secondary combustion takes place in the chamber C, and the products of combustion then pass through the perforated wall W to the chamber L in which are situated the superheater tubes. H, I, and K are respectively the inlet, intermediate, and outlet steam drums. The temperature of the superheated steam can be adjusted by varying the rate of supply of steam to the blower.

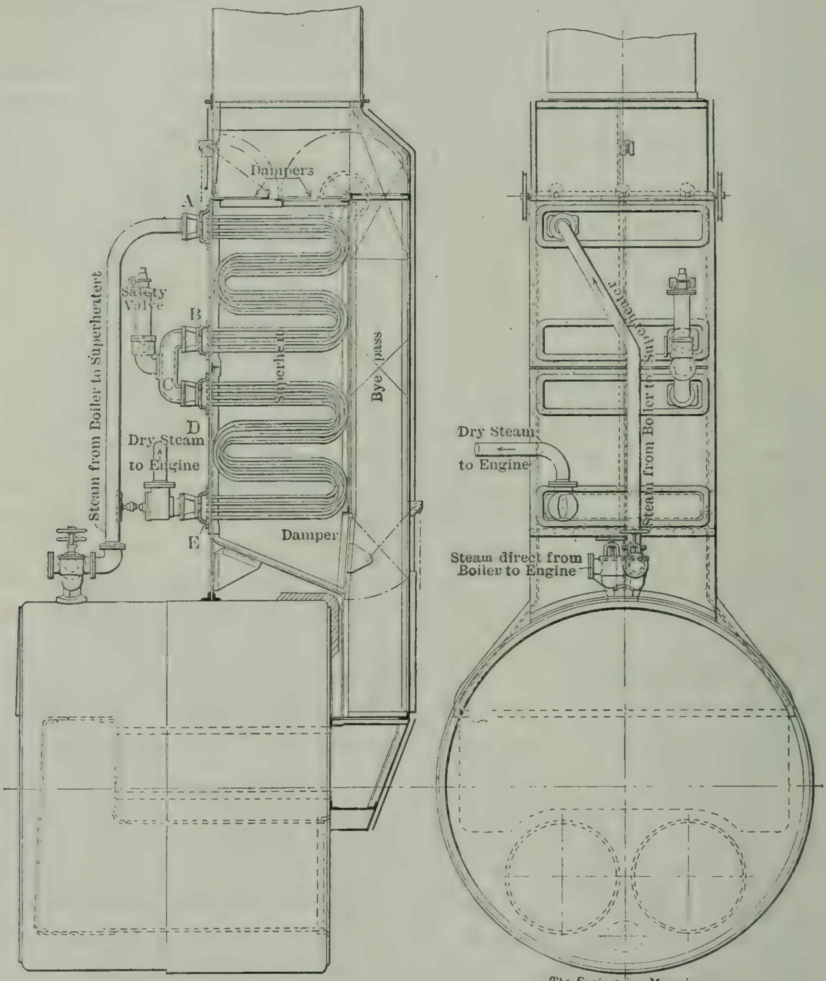
Superheaters provided with furnaces of the producer type have the advantage over those provided with ordinary furnaces that with a uniform flow of steam through them, they require less attention, and with a variable flow of steam the temperature of the steam is more easily controlled. It will be obvious that, with a furnace as shown in Figure 6, the amount of heat given to the superheater can be varied much more quickly than with an ordinary furnace.

A separately fired superheater has many advantages. It can be used in conjunction with any boiler or set of boilers without disturbing others, and is independent of the temperature at which the waste gases leave the boiler or boilers. In a well designed stationary boiler with natural draught, the waste gases should pass up the chimney with only sufficient heat to give the necessary draught, and the chimney should be designed so as to allow of this waste-gas temperature being as low as is reasonably possible. With a stationary boiler designed for forced or induced draught the temperature of the gases passing up the chimney should by the design of the boiler be brought still lower—though often the opposite is the case. With such boilers the waste gases cannot be used for firing superheating tubes, as no heat can be spared. A separately fixed superheater is in most cases to be preferred for such boilers.,

Another advantage possessed by the independently fired superheater is that it can be stopped and started without affecting the efficiency of the boiler or boilers with which it is used in conjunction. Another advantage is that the independent-superheater fire need not be started till steam is passing, or just about to pass, through the superheater tubes on its way to the engine, thus preventing these tubes being burnt out through being subjected to a fierce heat without any cooling agent flowing through them in the interval while the water in the boiler is being raised to boiling point.

Method 2. Heating the Superheater by the Hot Gases on their Way from the Boiler to the Chimney.—This method ought to be subdivided into two classes, which may be very different from each other.

A.—all the hot gases leave the boiler at approximately the same temperature (at any instant) and pass to the superheater and then to the chimney.

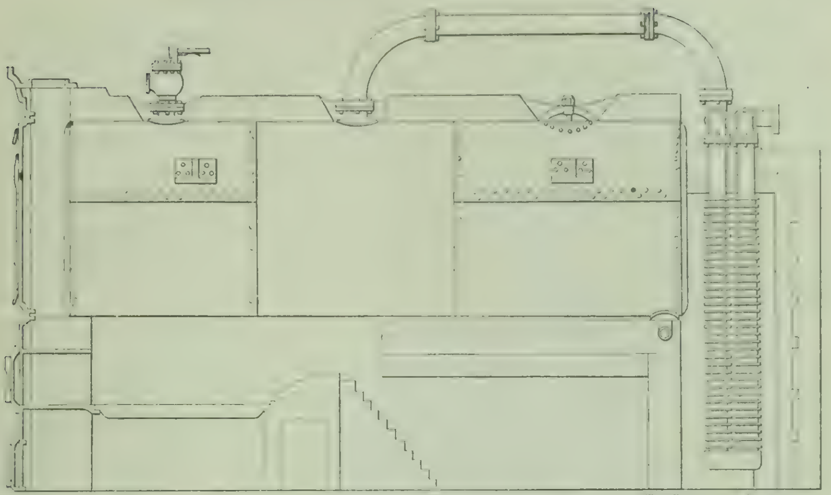

Dampers
A
Steam from Boiler to Superheater
Safety Valve
B
C
D
Dry Steam to Engine
E
Superheater
Bye pass
Damper
Steam from Boiler to Superheater
Dry Steam to Engine
Steam direct from Boiler to Engine

The Engineering Magazine

FIGS. 7 AND 8. SUPERHEATER MADE BY THE CENTRAL MARINE ENGINE WORKS, WEST HARTLEPOOL.

B.—The hot gases are divided in the boiler flue or flues. Part are shunted off to the superheater, from which they pass to the chimney, while the other part are given a further course through the boiler and then pass direct from the boiler to the chimney.

An example of Class A is shown in Figures 7 and 8, which il-



The Engineering Magazine

FIG. 9. FOSTER STEAM SUPERHEATER, APPLIED TO HORIZONTAL RETURN TUBULAR BOILER.

Power Specialty Co., New York.

lustrate a design of superheater being made at The Central Marine Engine Works, West Hartlepool. The superheater is shown fitted to a two-furnace return-fire-tube marine boiler. The superheating tubes are each made, as will be seen, with four straight lengths and three curved connections, and are arranged in two sets in series in the front uptake of the boiler. A by-pass is provided to allow the hot gases to pass direct to the chimney without passing over the superheating tubes, and dampers are provided as shown to control the flow of the gases. The steam from the boiler is led as shown to the pocket A, whence it enters the top ends of the top set of superheating tubes, down which it passes to the pocket B. It is then lead by the pipe C to the pocket D, which communicates with the top end of the second set of superheating tubes. The steam passes down these tubes to the pocket E, which is connected by way of a stop valve with the steam pipe leading to the engine. It will be seen that the superheater is arranged in counter-current fashion, which should be a decided advantage in a superheater of this nature, if the temperature of the gases is fairly low, as it probably will be.

An example of class B is shown in Figure 10, page 953, as used in a single-screw vessel having two boilers of the usual fire-tube marine type. The index accompanying the drawing indicates the principal parts. The heating surface consists of two sets of wavy vertical tubes and the steam passes up through one set of tubes and down through the other set. The portion of the hot gases used for heating the superheater is led from the combustion chamber of the boiler through tubes F to the casing containing the superheater tubes, whence the funnel 11 in each case leads away the waste gases to the main funnel. A small fan is provided which suplies an air jet which by an injector action draws sufficient of the hot gases through the superheater casing. This air jet is used to regulate the amount of superheat of the steam. The remainder of the hot gases passes from the combustion chamber through the fire tubes to the front uptake in the usual manner.

This method (both cases) of heating the superheater tubes has the disadvantage compared with Method 1 (independently fired) that the temperature to which the tubes are subjected is apt to vary considerably. It is therefore difficult to obtain a constant temperature for the superheated steam. This is especially the case when, owing to a varying demand for steam, the consumption of fuel per hour is not constant. It is true that when the boiler is working at high power, the steam flows at a higher velocity through the superheating tubes than it does when the boiler is working at a lower rate, and the steam therefore remains a shorter time in the tubes, and has less time to take up heat, and this serves to compensate to a certain extent for the difference of temperature of the hot gases impinging on the tubes. It would be difficult, however, to arrange for anything like a perfect compensation, even if the stoking were always the same for a given delivery of steam from the boiler. This constant relation between the stoking and the delivery of steam cannot however be counted upon with a fluctuating load—the boiler must act to a certain extent as a reservoir of energy. The difficulty of giving the steam a uniform superheat is therefore increased. With this method of heating the superheater, we must deal with the problem also of preventing the superheater tubes being seriously overheated in the period while steam is being raised and before any is passing out of the boiler. This is sometimes prevented by flooding the tubes with water during this period. This method is objectionable however, and a better method which is sometimes adopted when the tubes cannot stand the heat is to by-pass the hot gases during this period, as shown in Figures 7 and 8.

Before leaving this method of superheating it seems right to mention that some water-tube boilers are arranged in such a manner that some of the tubes or parts of tubes contain only steam. These tubes or parts of tubes are exposed to the heating action of the gases

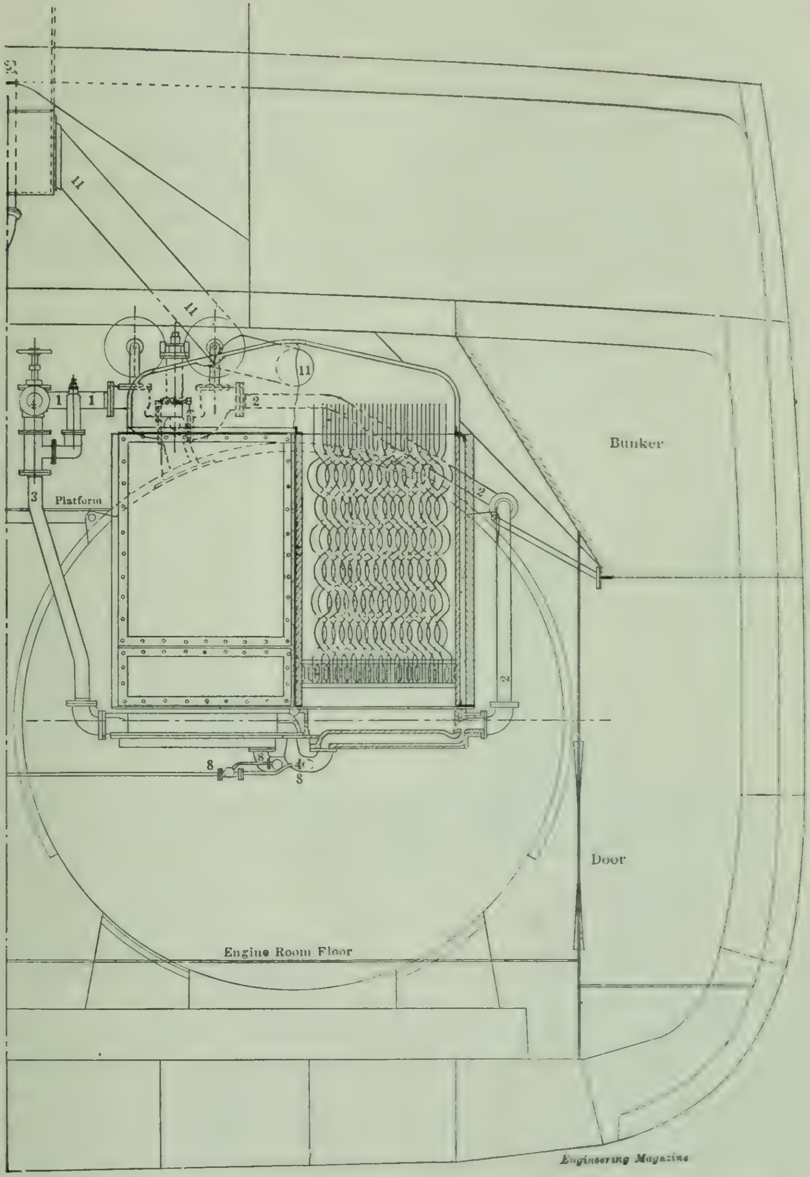


FIG. 10. ARRANGEMENT OF "CENTRAL" SUPERHEATER IN A STEAMSHIP.

Index of pipes. 1, steam direct from boilers to engine; 2, steam from boilers to superheaters; 3, steam outlet from superheaters; 4, main steam pipes; 8, drain pipes from superheaters; 11, superheater funnels. Central Marine Engine Works, West Hartlepool.

rising from the furnace and the steam is superheated. There is really in such cases a combined boiler and superheater. A good example of such a boiler is the Morrin "Climax" boiler.

One of these boilers having an evaporative capacity of 2,500 to 3,000 pounds per hour is shown in Figure 11. The boiler consists of a vertical cylindrical drum which is about two-thirds filled with water, the other one-third being filled with steam. Several furnaces are provided around the drum at its lower end, and above the furnaces and extending nearly to the top of the drum are a large number of small-bore curved tubes. The ends of these tubes are expanded into the drum, one end being higher than the other. Most of the tubes contain water only, but it will be seen that some have one end above the water level, while a considerable number have both ends opening into the steam space. P is a conical baffle plate which is used to prevent or at least to reduce the amount of water which is thrown into the steam space in the boiler. R is a perforated diaphragm and Q is a diaphragm which is unperforated except for two small holes to allow any water, carried over in the curved tubes, to drain back to the water portion of the drum. The products of combustion pass upwards from the furnaces and come into contact first with the water tubes and then with the superheater tubes. Lastly the hot gases come in contact with a feed-water coil,

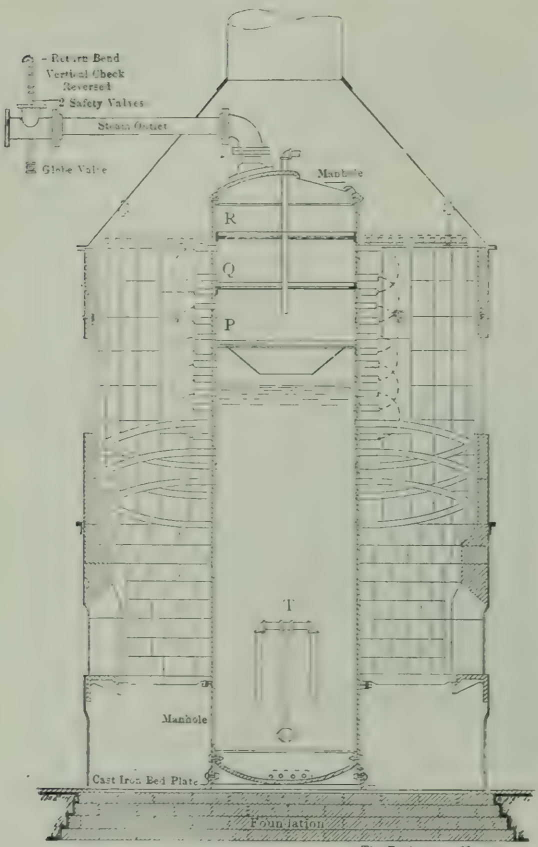
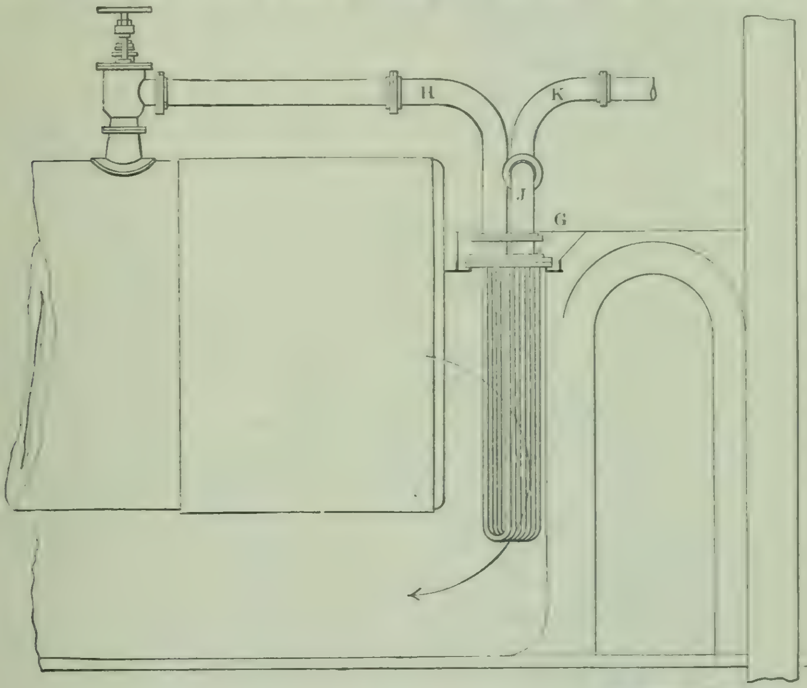


FIG. 11. MORRIN "CLIMAX" WATER-TUBE BOILER.
Built by the Clonbrock Steam Boiler Works, Brooklyn, and B. R. Rowland & Co., Ltd., Reddish, England.

through which the feed water is passed before being admitted to the drum by way of the pipe T.

Method 3. Heating by the Furnace Gases Before They Have Ceased to Act on the Boiler.—This method is exemplified by the superheaters shown in Figures 12 to 19.

Figure 12 shows a superheater constructed and fitted to a Lancashire boiler by Messrs Galloways, Ltd., of Manchester. The hot gases impinge on the superheater tubes after leaving the internal boiler flues and before passing along the bottom flue (to return by the side flues to the chimney). The superheater tubes are of U form and their ends are fixed in a tube plate forming the lower side of a flat two-chambered box. This box is shown at G in Figure 12. It receives steam into one chamber by the pipe H, and the steam after passing through the U tubes (which are all in parallel) enters the other chamber of the box which it leaves by two pipes J which unite in the pipe K. Messrs. Galloways construct the entire superheater of Siemens-Martin mild steel.



The Engineering Magazine

FIG. 12. GALLOWAYS SUPERHEATER FIXED IN DOWNTAKE OF LANCASHIRE BOILER.

Figures 13 and 14 show a design of superheater constructed by

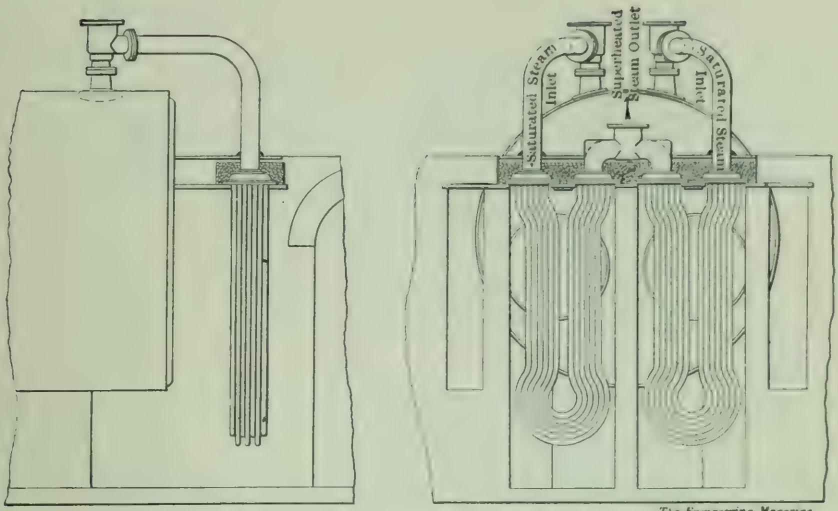
Messrs Tinkers, Ltd., of Hyde, near Manchester. The plates are constructed of Siemens-Martin mild steel and the tubes are weldless and of mild steel. With this class of superheater dampers are often provided so that when desired the hot gases can be by-passed clear of the superheating tubes.

A damper is provided in the construction shown in Figure 15, which illustrates a double boiler fitted with a superheater constructed by A. Hering of Nürnberg. The gases, leaving the internal flue in the lower shell, pass according to the position of the sliding damper either through the superheater chamber as shown in the figure or direct to the chamber behind the upper shell. They then pass through tubes in the upper shell.

Messrs. Easton & Anderson employ Field tubes in their superheater for use in the downtake at the back of a Lancashire boiler, and the Cruse Controllable Superheater Company have a design on the same lines.

The Babcock & Wilcox combination of superheater and water-tube boiler is shown in Figures 16 and 17. Two T tubes, L, L, are arranged in the steam-and-water drum. The heads of these T tubes are situated well above the water level and the tubes convey the saturated steam through the bottom of the shell to the box M of the superheater. From this box the steam flows through the superheater tubes to the box N, and the superheated steam leaves this box by the pipes P, P, which unite at the coupling piece Q. The superheating tubes are all in parallel and are arranged in sets of four. They are solid-drawn steel tubes and before being bent are of about the same length as the boiler tubes but of much less diameter. They are expanded into the boxes M and N in sets of four and an inspection cap is provided on each box for each set of four tubes to allow of the tubes being examined. The curved ends of the tubes which cannot so readily be examined are protected by the baffle R. Instead of conveying the saturated steam to the box M in the manner illustrated, Messrs. Babcock & Wilcox usually now employ outside pipes for this purpose, the steam leaving the boiler drum at the top in the usual manner.

Figure 18 shows a somewhat similar superheater constructed and fitted to a boiler by Messrs Walther & Co., of Kalk bei Köln am Rhein. The arrangement of baffles among the water tubes of the boiler puts this superheater more in the direct path of the gases from the furnace to the chimney, but at a later position in the path than is the case in the Babcock & Wilcox arrangement. For this reason



The Engineering Magazine

FIGS. 13 AND 14. SUPERHEATER FOR LANCASHIRE BOILER, INSTALLED IN DOWNTAKE FLUE AT BACK END.

Constructed by Messrs. Tinkers, Ltd., Hyde, near Manchester, England.

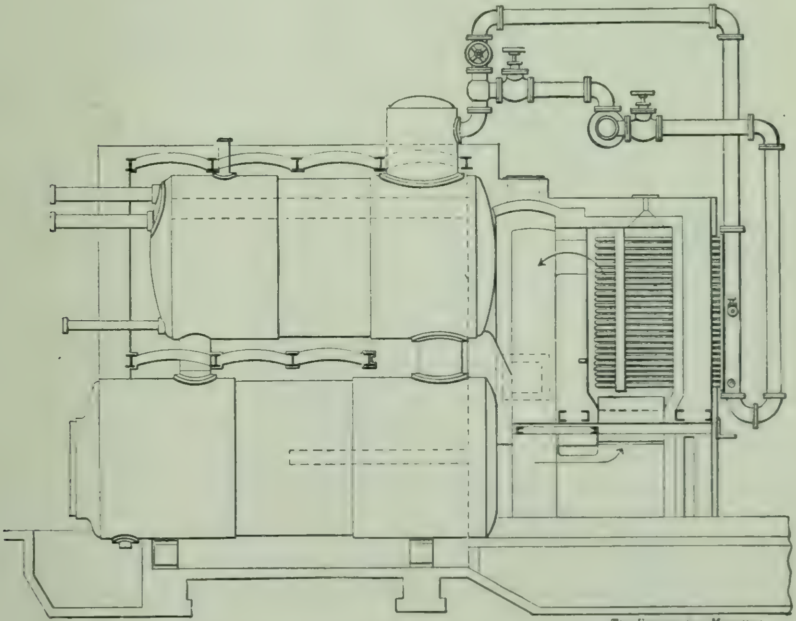


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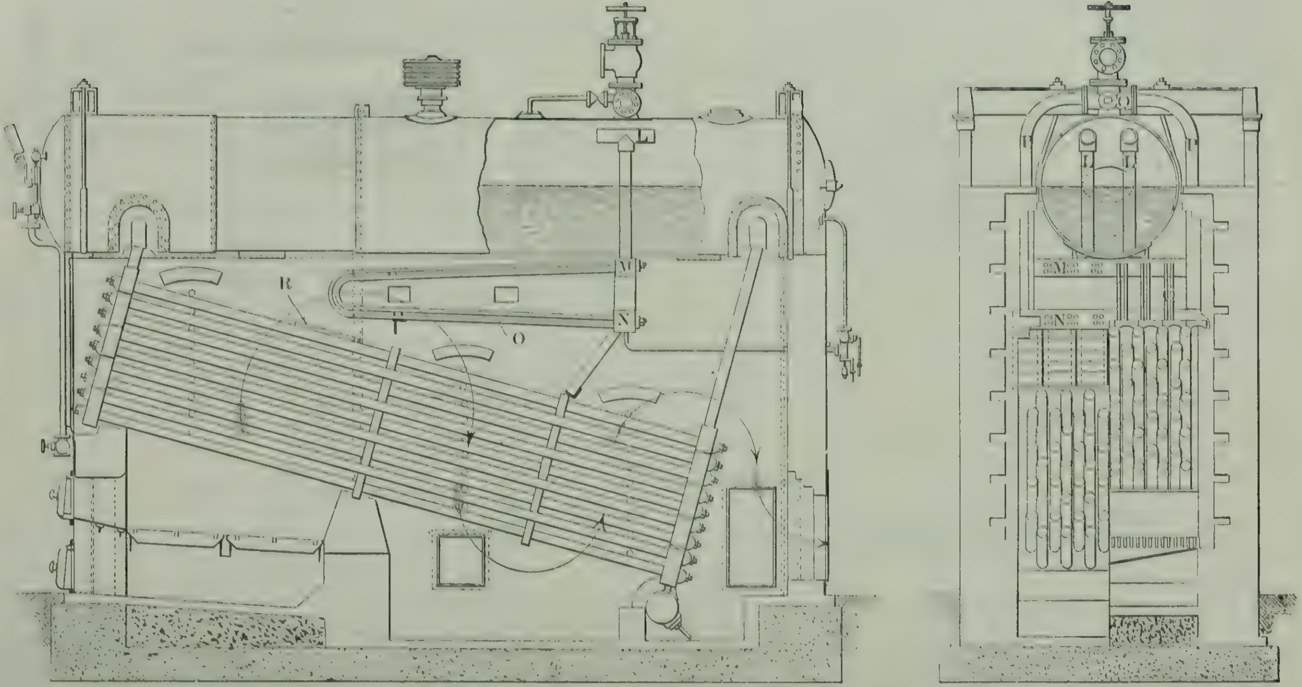
FIG. 15. HERING SUPERHEATER FITTED TO A DOUBLE BOILER.

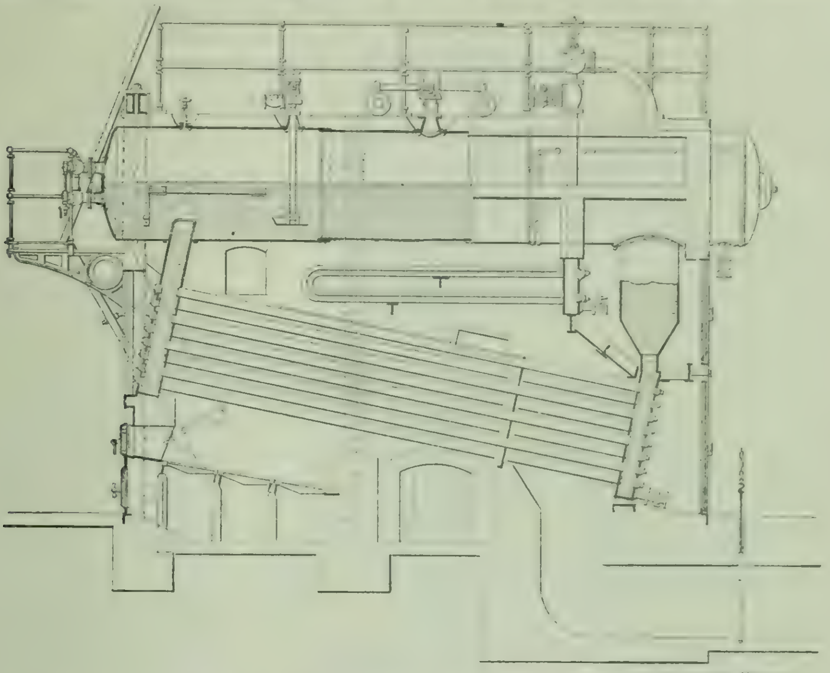


The Engineering Magazine

FIGS. 16 AND 17. LONGITUDINAL AND TRANSVERSE SECTIONAL ELEVATION, BABCOCK & WILCOX BOILER AND SUPERHEATER.

the Babcock and Wilcox arrangement appears to me to be rather the better of the two as regards the variation of temperature to which the superheater will be exposed.

This method of heating the superheater tubes sometimes approaches very close to Class B of Method 2, as sometimes, owing to the position of the superheater tubes, some of the waste gases can get past without coming into intimate connection with the tubes.

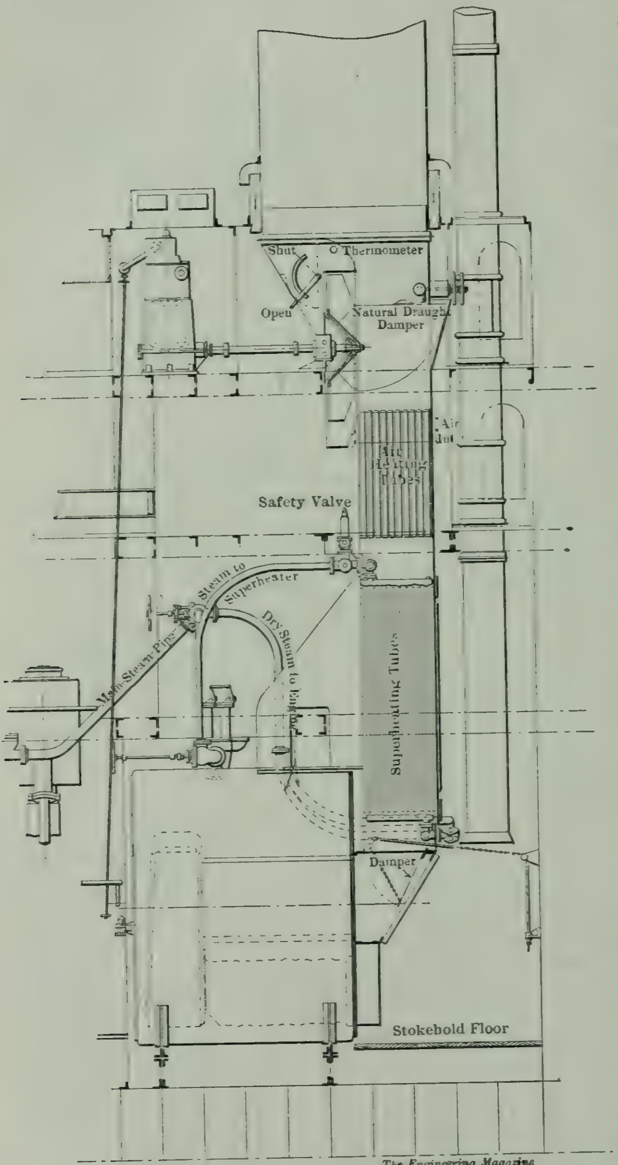


The Engineering Magazine

FIG. 18. WATER-TUBE BOILER AND SUPERHEATER, WALTHER & CO., KALK BEI KÖLN AM RHEIN.

This method has much the same defects as Method 2. The superheating tubes are exposed to a fiercer heat than in Class A of Method 2, and therefore the danger of their being overheated is increased; but this method has the advantage that it can be applied to boilers from which the waste gases leave at too low a temperature for Method 2 to be employed. Method 3 allows of a smaller heating surface in the superheater than in either class of Method 2.

A method of superheating intermediate between Methods 2 and 3 is illustrated in Figure 19, next page, which shows a couple of three-furnace single-ended marine boilers fitted with superheaters. The hot gases act on the superheater only after they have finally quitted



The Engineering Magazine

FIG. 19. ARRANGEMENT OF INDUCED DRAFT AND "CENTRAL" SUPERHEATERS ON THE STEAMERS INCHDUNE AND INCHMARLO.

Marine boilers and superheaters built by the Central Marine Engine Works, West Hartlepool, England.

the boilers; but, after acting on the superheaters, the hot gases are employed to heat air passing to the boiler furnaces. The drawing shows the design of boilers and superheaters supplied by The Central Marine Engine Works to the steamers Inchdune and Inchmarlo of Messrs. Hamilton, Fraser & Co. of Liverpool. The superheater for each boiler consists of three sets of vertical wavy tubes situated in the front uptake. Each set conveys steam from a top header to a bottom header, the steam thus passing in countercurrent fashion in the opposite direction to the hot gases, which, after leaving the superheater, continue their upward journey through a set of tubes (shown in Figure 19) which are used for heating the air passing to the furnaces. The air is drawn through between these tubes, through these furnaces, through the fire tubes in the boiler, and along the uptake, by fans (one for each boiler) according to the Ellis & Eaves system of induced draught.

The figures in the table below were obtained in a test on board the steamer Inchmarlo on October 26th, 1900. The working pressure of the boilers was 267 pounds and the engines supplied by these boilers were of the five-cylinder, quadruple-expansion type. The high-pressure cylinder was lined but not steam-jacketed. The first intermediate cylinder, the second intermediate, and the two low-pressure cylinders were all steam jacketed.

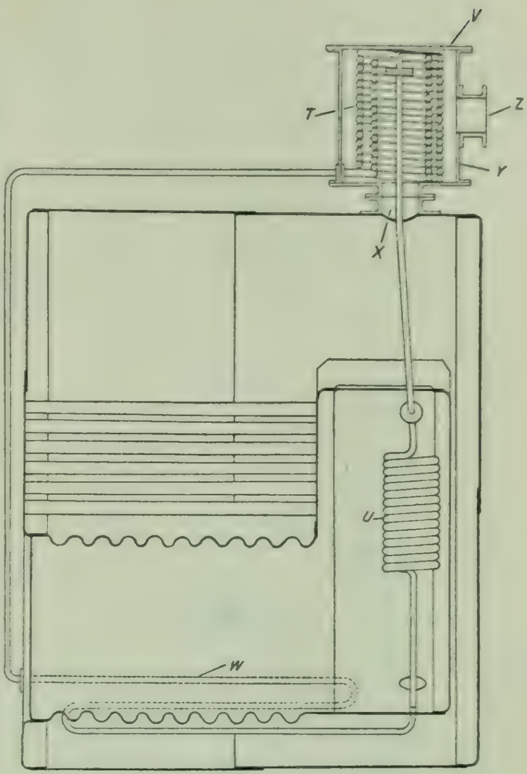
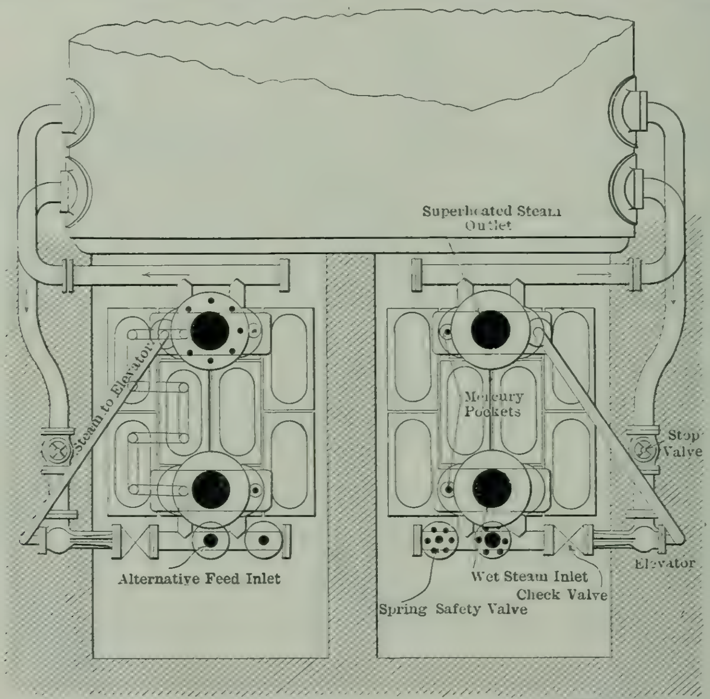


FIG. 20. PROF. WATKINSON'S PROPOSED DEVICE FOR SUPERHEATING BY MEANS OF AN AUXILIARY FLUE.

	Temperature in degrees F.
On deck	53
In stokehold	77½
Air entering furnaces	299
Hot gases below superheater	587
Hot gases above superheater	543
Hot gases above air-heating tubes	404
Steam at inlet to superheater pipes	412
Steam after passing through superheater	469½
Steam at high-pressure steam chest	447

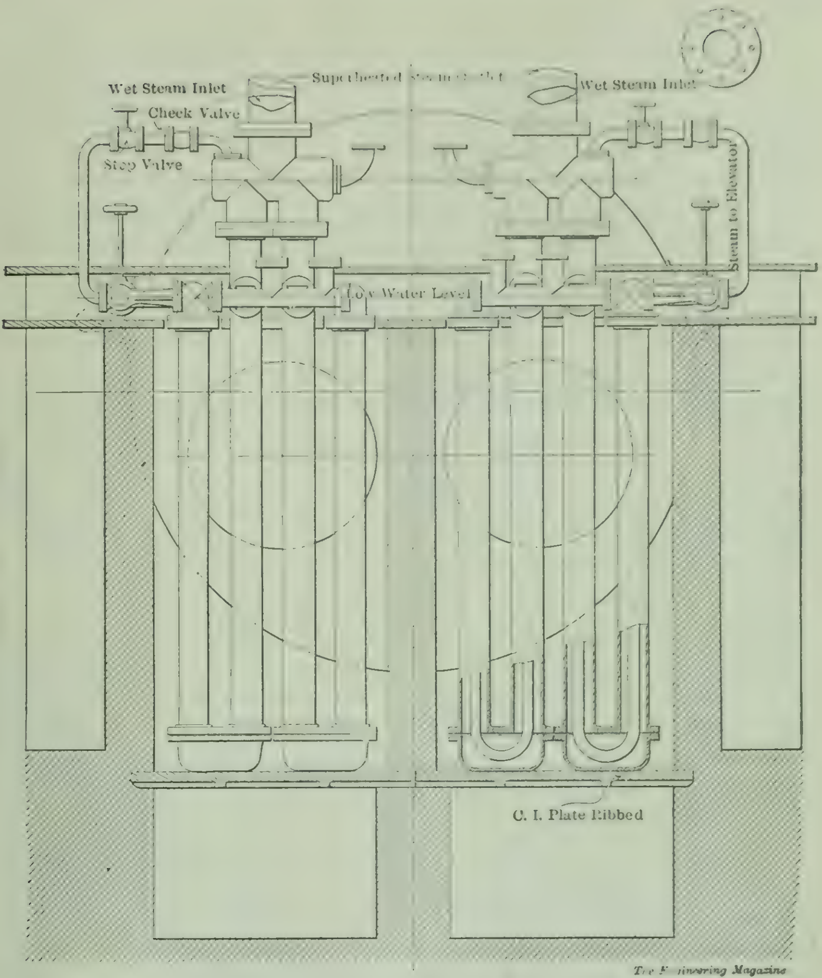
Method IV. Employing a Fluid which Is Itself Heated by the Furnace Gases and which Imparts Heat to the Steam.—This method has been proposed by Prof. Watkinson, who suggests the construction shown in Figure 20. A fluid having a high boiling point is contained in a tube U, placed in the combustion chamber of a boiler and formed into a coil to give sufficient heating surface. This coil is connected to a double superheating coil T placed within a casing at the top of the boiler, and this in turn is connected to a pipe W which is arranged with three laps in the (usually) still water at the bottom of the boiler. The pipe W is connected to the coil U, thus forming a closed circuit. The fluid with the high boiling point can flow along this circuit but never mingles with the water or with the steam. The steam passes at X from the boiler to the superheater casing V, and leaves this casing at Z. By this method of superheating, there can be no danger of tubes containing superheated steam being subjected to an excessive temperature. A relief valve can be arranged to prevent the pressure (and therefore the temperature) of the auxiliary fluid exceeding a certain amount. The lengths of pipe W are also useful in improving the circulation of the water in the boiler, especially during steam raising.



The Engineering Magazine

FIG. 21. CRUSE SUPERHEATER. HORIZONTAL SECTION.

Some of the advantages of such an arrangement are obtained in the Cruse controllable superheater without the employment of an auxiliary fluid.



The Engineering Magazine

FIG. 22. CRUSE SUPERHEATER FITTED TO LANCASHIRE BOILER.
Cruse Controllable Superheater Co., Salford.

In the Cruse superheater the steam passes through tubes of fairly large diameter—6 inches is a common size, but tubes as large as 9 inches in diameter have been used. The tubes are built up and arranged in sets of 16, 24, 32 or other convenient number.

Figures 21 and 22 show a 32-tube Cruse superheater applied to a Lancashire boiler. It will be seen that a chamber of considerable size is placed behind the boiler. The tubes are arranged in four sets of eight each and rest on a cast-iron ribbed plate. In each set of eight tubes, the steam passes alternately up and down the tubes, that is to say, the eight tubes are in series. The superheating tubes are of steel, hot-rolled and weldless. The copper water pipes in each set of eight tubes are connected together in series. The circulation of water in the inner pipes prevents the steam in the superheater tubes from getting overheated and the provision of an annular passage instead of a circular passage for the steam tends to break it up and get it uniformly heated. It will be obvious on a little consideration that heat radiated from the inside surface of a superheating tube is in the ordinary case received by the opposite walls of the tube. In the case of the Cruse tube, however, a large part of the heat radiated from the inner walls of the tubes passes to the water tubes and is absorbed by them. It is not at all necessary for the water tube to touch the outer tube in order to relieve it of a large amount of heat. The amount of heat conducted by the steam from the outer to the inner tubes will probably be comparatively small, but the amount of heat radiated from the outer tubes to the inner tubes and not returned must be very large when there is a considerable difference of temperature betwen outer and inner tubes.

It is not an uncommon practice to superheat only part of the steam generated by a boiler or battery of boilers and to mix this steam with saturated steam (sometimes fairly wet) with the object of preventing or lessening the risk of the steam passing to the engine or engines at an excessively high temperature. This method of working will not of course prevent fluctuations in the temperature of the steam passing to the engine, but the maximum temperature which is likely to occur will be less than it would otherwise be.

An ingenious device for controlling the temperature of superheated steam passing to an engine is the invention of Mr. J. E. L. Ogden of Liscard, Cheshire. This device provides for superheated steam and saturated steam being mixed together in certain proportions before passing to the engine, the proportions being controlled thermostatically according to the temperature of the superheated steam passing to the engine. This device has the advantage that, if the heat to which the superheated steam is subjected should fall off, the saturated steam can be completely and automatically cut off and the low-temperature superheated steam from the superheater alone used; while if the superheater be subjected to an excessive temperature, only a very little of the superheated steam will be allowed to mix with the saturated steam and pass along the main steam pipe to the engine.

A DISCUSSION OF SYSTEMS OF POWER SUPPLY FOR MINE OPERATION.

By F. V. Henshaw.

Mr. Henshaw's article is especially interesting as an extension of the discussion suggested by the contributions of Dr. Porter and Professor Roberton in our special Labor-Saving Number of January last.—THE EDITORS.

POWER supply for mining operations is of prime importance, affecting as it does the output, cost of production, and even the life of workmen in one of the greatest industries. As compared with the power requirements of a city or factory, those for a mine are similar, with these additions:—The power must be transmitted through tunnels and rooms in proximity to workmen. There must be nothing to vitiate the surrounding air. The power and transmission appliances must be able to withstand moisture and explosive and sulphurous gases. They must meet special hoisting conditions in deep mines. The power must be well adapted to rock drilling. The system that has been found best for cities and factories should therefore be best for mines, if it can be made to meet these additional requirements in a satisfactory manner.

In the generating plant, where few of these conditions begin to apply, the general requirements are of course extremely close to those of the general power plant, but the situation of the mine or the character of its allied workings may impose special limitations or offer particular opportunities.

The steam engine, dating it from Watt's first patent, is one hundred and thirty-five years old, and with the utmost refinement in large powers has attained a thermal efficiency of 22 per cent.; an extreme economy under ideal conditions would be 1 pound of coal per indicated horse-power hour, for the whole steam plant. No such efficiency can be obtained in practice, and 1.5 pounds of coal per indicated horse-power hour, is about the best that can be expected under the most favorable conditions. The efficiency of steam turbines is about the same as that of the most economical piston engines, for the same kind of service.

The steam turbine has a considerable advantage over all piston engines in space and cost when used for driving dynamos, as the latter can be made much smaller and cheaper on account of the high speed. This high speed is well suited to alternating-current dynamos, but generally objectionable for direct-current machines of the usual commutating type. The "unipolar" type of direct-current dynamo is now being developed for direct connection to turbines and is very promising. The economy due to concentrating the power generation for a mine or several mines at one point is obvious. An interesting case of evolution in this direction is the Hampton plant, near Scranton, Pa., where a central boiler plant for five collieries was built a short time ago, power being transmitted by means of five steam mains up to a distance of 3,140 feet.

The gas engine is about forty-four years old, has attained a thermal efficiency of 26 per cent. in small sizes, and with modern gas producers can develop an economy of 1 pound coal per indicated-horse-power hour, under conditions of practice. Gas engines as large as 1,500 horse-power were built five years ago, and their practical operation has been thoroughly tested in Europe. One might consider that the gas engine practically begins where the steam engine stops, as far as fuel economy is concerned.*

For all mines having coke ovens, or blast furnaces within a reasonable distance, gas engines are the natural sources of power. Attention has been drawn of late to the vast power wasted in the making of coke and iron. It is not within the province of this article to take up this subject at length, but the following figures may be cited as indicating the magnitude of a source of power, now largely wasted, which will surely be put to profitable use in the future:—

Mr. C. G. Atwater states† that in the United States 95 per cent. of the coke was made without recovery of the by-products in 1901, and in England 80 per cent. was made in the same manner in 1898. Mr. A. M. Gow calculates‡ that a blast furnace producing 15 tons of iron per hour develops enough gas to furnish 9,000 horse power over and above the power required for the furnace blowing engines.

Objections have been made to the gas engine, on account of its relative size and consequent high cost, lack of starting power and overload capacity, and the necessity that has been found for cleaning of its interior parts, resulting in a shut-down for several hours at regular intervals. Considering the power plant as a whole, it will be seen that against the size and cost of the gas engine itself, there are offset the condensers, economizers, mechanical stokers, and complicated steam and water-piping system, with pumps, heaters, etc., all of which are required in an economical steam plant, but which are either done away with entirely, or greatly simplified in a gas plant. The gas producer is simpler and cheaper than an equivalent high-pressure boiler. Gas permits an efficient storage of power, and has a considerable advantage over steam in this respect. With liberal gas holders there is always a reserve of power immediately available.

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* See Dr. Mond's remarks on paper by H. A. Humphrey on Power Gas and Gas Engines, Inst. M. E., Dec., 1900.

† Transactions Am. Inst. Mining Engineers, Oct., 1902.

‡ Transactions Engineers Soc. Western Penn., April, 1903.

The lack of starting power and overload capacity are certainly disadvantages, but the first is not very serious in power stations where engines do not start under load, and the second simply means a liberal size of engine. The trouble from fouling of valves has been largely overcome and it can reasonably be expected that it will be eliminated as a serious factor.

Considering now the matter of the distribution of power, we note that central power plants for cities and factories have been in operation for many years, using high-pressure water, compressed air, and electricity. Rope transmission and steam may be omitted from the present discussion. Gas has been used almost exclusively for lighting and heating, and while the possibilities of distribution of power by gas are considerable it is highly objectionable in mines.

Of the three successful methods, electricity has so far exceeded the others in the extent and magnitude of its use that it can hardly be said to have a rival in the general field. The distribution of hydraulic power has been in use in nine cities in England for many years, but compared with electric plants these undertakings are insignificant. These hydraulic plants would doubtless have done better had the impulse wheel been developed earlier and thus given them a simple and efficient motor. The exhaust water is an objection that puts the hydraulic system out of consideration for distribution, except possibly in some surface workings.

Where high natural heads are available hydraulic transmission may be utilized to bring power to the mine, there to be converted into electric or compressed-air power for distribution. Local conditions do not always lend themselves favorably to the construction of a pipe line, while there are practically no limits in the case of electric power lines. This is a plain engineering question, which must of course be decided for each case according to the local conditions, taking as the basic factors relative first cost, together with the advantages of a concentrated power plant at the point of distribution, *versus* a distant power station transmitting to a sub-station.

Compressed air demands particular consideration in the present discussion, as not only does it come into the class of successful methods of power distribution, but it is peculiarly well adapted to mine work, and has, in fact, been developed chiefly for that purpose, and for civil-engineering works of the same general nature. Compressed air developed by steam power has been distributed for general power purposes, over an area of several miles, in the city of Paris for some seventeen years, a sufficient demonstration of its engineering and commercial success. It is, however, hardly necessary to cite further instances to demonstrate the importance of compressed air for power transmission, and the discussion resolves itself into a consideration of the merits and limitations of compressed air and electricity. Considering these two agencies from the point of comparative advantages in transmission, and taking Prof. Unwin's* figures for air power, there is little to choose between air and electricity on the score of efficiency, though the loss from leakage, in practice, would probably be much greater with the former. But high-pressure air mains are less flexible, and probably more expensive in most cases, than electric power mains. Certainly compressed air could not be considered for transmission, unless it is also used for general distribution. For coal and iron fields, having power-gas by-products available, it might be found best to locate a central plant at a distance from the source of gas, conveying the gas by a pipe line.

The distribution of power, however, is largely the key of the whole problem. The reasons that have given electricity almost the entire field of general power distribution might be considered sufficient to establish its universal use in mines. Such, however, is not the case, and the best practice today may be found in the combination of air and electricity. Evidently electricity is not considered as meeting all the special requirements of mine work. The reasons are not far to seek, and the question to be considered is—can electricity be made to do equally well the work for which air is now used?

Just as the voltage of great electric-power stations has been fixed by the possibilities of one device—the incandescent lamp—so in another way the air-power system owes its existence in mines to the percussion drill. Electric power is not well adapted to develop reciprocating motion for rough work. The simple and rugged construction possible in a piston drill, and above all the elastic steam or air cushion, gives these agents great advantage over electricity. A number of electric percussion drills have been and are made, using either solenoids to develop reciprocating motion or converting rotary motion of motors to reciprocating by mechanical means. One form of the latter type might be considered electro-pneumatic, the drill piston being actuated by compressed air delivered by what may be called the motor-driven piston.

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* The Transmission and Distribution of Power from Central Stations by Compressed Air.

The advantage of permitting the adoption of a single agent for all power distribution, and its high efficiency, are in favor of the electric drill; but in simplicity, strength to withstand rough usage, and general reliability, the air drill still holds its own. It is doubtful if the electric drill can be made to compete with the air drill strictly on its own merits, but at the same time it hardly seems to have received all the attention it deserves. From the nature of electric power, one would look for improvements in the direction of rotary drills.

With the exception of the rock drill, there is little argument in favor of air versus electricity in mines. There are no problems in haulage to which the electric motor is not well adapted. The control of motors for very large winding machines is somewhat simpler with air than electricity, but the latter power gives a more uniform torque, equal or greater nicety of adjustment, and higher plant efficiency. For cable haulage up slopes, and for traction work, electric motors are well suited. The air locomotive has a limited mileage and requires a supply system at 500-pounds to 1,000-pounds pressure, which is costly, not altogether safe, and is too high for drills, hence making a double air-supply system necessary. The air locomotive is also more bulky and generally requires more head room than the electric locomotive. The electric "gathering" locomotive enables cars to be hauled from the working faces about as well by electric as by air power. At the Ehrenfield, Pa., coal mines there is a novel system of traction whereby grades of some 10 per cent. to 12 per cent. are negotiated by electric locomotives by means of a third rail in which are holes engaging the teeth of sprockets on the locomotive. The third rail is insulated and also acts as a conductor. On levels or light grades the locomotive is worked from an overhead trolley in the ordinary way.

Air power is advocated as better than electricity in that it assists ventilation in mines. Ventilation by high-pressure air is not good engineering, and the power wasted in the air drills would make things better for the miner if expended in motor-driven fans drawing air from main headings or ventilation shafts. Electric mains are better adapted to running through shafts, crooked tunnels, etc., than any other power conveyor. There is but one requirement—they must be insulated. Without going into details, it can be confidently stated that there are no difficulties in insulating conductors in mines that cannot be overcome by intelligent engineering using ordinary materials. Outside of specialists in electricity few persons realize how little insulation a system may have and still keep going. This, together with the extreme flexibility and adaptability of electric wires and motors, has resulted in much construction work the equivalent of which would not be tolerated in any other branch of engineering. As a natural result, troubles due to insulation failures have been exaggerated.

The danger from electric sparks in gaseous mines cannot be eliminated, though it can be greatly reduced by care in the electric installation. The alternating-current induction motor without contact rings cannot produce sparks except it be damaged, and controlling switches can be made to break circuit under oil. There is always liability to spark ignition with electric traction. Careless handling of lights and explosives is a far greater menace than a well designed and carefully inspected electric system. In workings in which open lights and explosives are prohibited, and which cannot be sufficiently ventilated, compressed air should be used for greatest safety.

In respect to danger from shock, it may be said that this also has been exaggerated, it being human nature to fear the mysterious. When a man is killed by a falling roof, dynamite explosion, or even by foul gas from a "flaming" air compressor, the cause of death is understood. To be knocked over by simply touching a wire is uncanny and impresses the imagination. Up to 300 volts the danger from shock is nil, while above 500 volts it begins to be serious. It also happens that 500 volts is about the maximum for satisfactory direct-current motors, which are the type best suited to traction work. The data as to the electric pressure that will kill are very inexact, but judging from the few fatal accidents in proportion to the vast number of persons handling 500-volt power in street railway and other industries the risk from that pressure cannot be great. From my personal experience and observation of many shocked persons, I would say that 500 volts cannot kill a normal man unless he is connected in circuit so that he cannot break loose. Such a condition is very rare and happens as a rule only to electrical workmen.

While an exact statement as to the element of danger from shock due to the introduction of 500-volt pressure into mines cannot be made, it can be fairly said that this element does not add materially to the risks of mining. It is indeed a question whether the elimination of animal power and underground stables by substituting 500-volt traction would not, on the whole, increase the miner's expectation of life. To anyone familiar with the work now done in mines and steel works by electric power the question of power distribution in the former is confined to the kind of electrical machinery and methods to be adopted.

COST KEEPING ON GENERAL CONTRACT WORK.

By A. W. Buel.

The purpose of this article is to bring to the attention of contractors engaged in building railroads, bridges, buildings, and public works the importance and value of accurate cost keeping and to induce them to contribute directly or indirectly to the current literature on the subject, on the principle that an exhange of ideas injures no one and benefits all. This is no more than a continuation and special application of the series of articles on "*Cost Keeping*" that have occupied a prominent place in THE ENGINEERING MAGAZINE for several years. Not often has a subject been presented by any periodical devoted to one group of industries that has received so much attention continuously for a long period, and few if any similar series have resulted in so much material benefit to industrial progress.

It may be that a considerable number of general contractors are now using up-to-date cost-keeping systems, and for the general success of this line of business it is to be hoped that such is the case; but diligent inquiries by the editors of THE ENGINEERING MAGAZINE have failed to elicit from more than 10 per cent. of those approached anything than can be called a system or method. If the other 90 per cent. are using modern methods, they are hiding their light under a bushel. The author and the editors will be well compensated for their initial difficulties and disappointments if this beginning leads to the encouragement of other contributions and the formation of a new body of cost-keeping literature in the field of general contract and construction work.—THE EDITORS.

THE remarkable growth of manufacturing industries during the past fifteen years, particularly in stability and competitive strength, has been contemporaneous with the development and introduction of systematic methods of cost keeping. It is not too much to say that one of the most important elements contributing to this growth has been the increasing efficiency of the system employed for auditing accounts. Without question much, is due to improvements in the other departments of our industries, but the suggestions to which these improvements are due, as well as the final judgment which has retained and passed them beyond the experimental stage, has often been based on the records of an accurate system of cost keeping.

A good system of cost keeping must be accurate, quick, and in ample detail. It should be adapted to the business and complete enough to give the cost of each element of the work separately, without being so cumbersome as to break itself down or become burdensome to the organization. The expense of a modern system need not be materially greater than that of an antiquated, crude, and inefficient way of keeping accounts. Above all, it must be such as to give the detailed costs of each part of the work while the business is fresh, and not weeks or months afterwards.

What systematic cost keeping in detail has done for manufacturing industries it can do for general contractors, and often in greater measure. It is generally admitted that the business of a general contractor is one of the most difficult industrial enterprises to manage successfully. As a general rule the organization is not entirely permanent, but changes to some extent with each new contract. The location of the work is first in one place and then in another, and whatever of permanency the organization possesses must be accompanied by the characteristics of mobility which introduce complications. Not only do most of the conditions of the work vary for each contract, but the kind and class of work may be entirely different. These and other difficulties that confront the manager of large and diversified contract works are sufficient to demand not only a good cost-keeping system, but the best that can be devised, one that will be to him both eyes and ears.

Elaborate cost-keeping systems, as well as mechanical inventions, have been devised to meet necessities. Their introduction in manufacturing industries has been brought about by the narrow margin of profits due to competition, the magnitude of the enterprises, and the complications of the operations. The question naturally airses, do the same causes exist on contract work?

Margins of estimated profits are fixed not only by competition but by the risk or unknown elements in the cost. In some lines of manufacturing, the risk, under normal conditions, is so small that a 5-per-cent. profit is acceptable in dull seasons, and at times of industrial depression many products are sold at cost. Under similar conditions the minimum *estimated* profit accepted by contractors varies from 10 or 15 per cent. up to 25 per cent. or over for subaqueous or other hazardous work, and a smaller margin is likely to have disastrous financial results. Briefly stated, the risks or unknown elements of cost range from about 10 per cent. upward, and just so much of a contractor's *estimated* profits are a pure speculation. The remainder of the *estimated* profit, after deducting the speculative risk, is the average or true profit, and the margin of the latter in contract work is not so much greater than in competitive manufacturing enterprises as is generally supposed.

The real average margin is small enough to demand rigid economy, and this can be maintained on extensive works only by promptly ascertaining the cost in detail. Anything that reduces to a minimum the unknown elements of cost and brings them under more perfect control, makes for financial stability, and this is the office of all cost-keeping systems.

That the magnitude of contract works as compared with manufacturing enterprises is sufficiently great to warrant the adoption of approved methods needs no argument, and the same is true of the relative complications involved in the operations. If any one should doubt this statement, it will suffice to mention the Geo. A. Fuller Co., with twenty or thirty skyscrapers under construction at one time and in several different cities, the New York and Boston Subway contracts, and many railroad-construction contracts ranging over a million dollars each. Much of this work is really more complicated than many lines of manufacturing, and a close analysis of the operations will often disclose many elements in that which at first seems quite simple.

A study of the question will show that the necessity for good cost-keeping systems on contract works is in most cases as great as in many manufacturing establishments where they have been introduced. The necessity existing, have contractors generally adopted modern systems, and if not why not? The replies to 90 per cent. of the requests for information as to how costs were kept and distributed are fairly illustrated by the following quotations,—some inquiries remaining unanswered.

> "Our methods of keeping up costs and estimates are so crude and antiquated they would be of no service to you."
>
> "We endeavor to divide our accounts on building work as much as possible, but without the co-operation of a man on the work it is a very difficult matter to analyze correctly the different charges."
>
> "We are well aware that great improvement can be made in this direction and trust your efforts will be productive of beneficial results."
>
> "The only system we have of cost keeping on contract work consists in having our foremen on the different jobs send in postal cards every evening, stating number of men employed, bags of cement and yards of sand used, and the amount of work finished each day."
>
> "The method followed by us in distributing costs is simply to divide up each foreman's work day, charging to the different accounts the proper proportion. * * * * * * We do not use any special blanks for this purpose."
>
> "My system of book keeping is very simple, and I do not think it would be of much benefit to you as regards finding out some new or better methods of keeping contract accounts. First, we pay weekly. Each foreman has a book and the labor is charged up to his particular job. Second, bills for material are required to be rendered monthly, and such bills are charged up to the job on which they are delivered. Third, most of my work being contract work, there is no question about final estimates. Fourth, all expense is charged up against loss and gain at the end of the season."

The evidence of these replies and an extended experience with contract work is conclusive that many contractors need a good cost-keeping system. It appears that in some instances they do not have the "co-operation of a man on the work" and that they have no special blanks. That is to say they have no system. But special blanks and a system are entirely useless unless well adapted to the business and easily kept up. A contractor who devises a "system" with a dozen or more blank forms to be filled out daily, weekly, and monthly (and generally nightly) by foremen, bosses, timekeepers, etc., the posting of which would keep several expert accountants busy, may expect to see his "system" break down. It often breaks down before it gets fairly started. Such failures do not end with disappointing the contractor, but too often in bankrupting him and in deterring other contractors from adopting any "system." Horse sense and good judgment alone are better than an ill conceived system, but they may be greatly reinforced by a good system adapted to the business.

There will generally be found on any piece of work enough men with sufficient ability to co-operate with the management in accurately recording costs. Simple blank forms, that the men available can understand, will secure the desired co-operation. The essential thing is to devise a system with blank forms that is adapted to the capacity of the men who are available to carry it out and to the particular operations in hand. In devising such a system, it is necessary to start with a clear idea of the resulting information and distribution of costs which is the object to be attained. "A little well done is better than much badly done" is a maxim that applies with great force to cost keeping; therefore it is advisable not to attempt too much refinement in starting a cost-keeping system, but rather begin it in a simple way and improve it in detail as the requirements of the business and opportunities present themselves.

I was once assistant engineer in charge on a small railroad contract and received instructions from the chief engineer to "keep as accurate an account as possible of the contractor's expenditures, both for labor and material." The only available assistance for this work was about half the time of an ordinary boy with a common-school education, whose salary was about $40 per month. A material book was opened in which were entered all materials received on the work, in accounts classified as cement, stone, lumber, broken stone, etc. Whenever possible, the quantities were verified by comparison with the way bills. The contractor's statements, verified by market prices, were accepted for the cost.

The labor account was kept in books, specially designed for the work, one page being used for each day. Below is shown a fac-simile page of these books. The labor on each section, station, or structure being kept in separate vertical columns, and the classification of the labor on the horizontal lines, as shown, the segregation of cost of labor for each part of the work or for each class of labor was permitted, if required. The total hours of each class of labor multiplied by verified rates gave the total labor cost for the day, which added to the amount brought forward gave the total labor cost to date.

	Shovel No. 1.		Shovel No. 2.														Total Hours	Rate	Total Amount	
	Pit	Dump	Pit	Dump																
Foreman																				
Laborers																				
Carts																				
Teams																				
Engineer																				
Fireman																				
Craneman																				
Oiler																				
Masons																				
Cutters																				
Smith & Help'r																				
Carpenter																				
Bricklayers																				
Total for 1897.																				
Amount brought forward.																				
Total to date.																				

REDUCED FAC-SIMILE OF BOOK FOR DISTRIBUTION OF LABOR ON CONTRACT WORK.

When the work was about half completed, the contractor told the president of the company that he was losing considerable money, but could not tell how much. In less than twenty-four hours from receipt of instructions, a full report was prepared from the records described above and from the measurements of work done, showing what had been earned under the contract, and that the cost to the contractor had exceeded the contract prices by a large amount. While this account was not exact, it was probably not more than 1 or 2 per cent. in error and was much closer than any statement the contractor was able to make. On the face of it, a well-known and very able railroad president gave the contractor a large bonus over and above his earnings, under the contract. This was, in this particular case, good policy on the part of the railroad company, but it was also an act of justice, and is described here to illustrate what even a very simple cost-keeping system can accomplish.

It is not material that the cost was kept by the railroad company's engineers in the case just described. If the contractor could have produced a record as clear, complete, and as well verified the result would have been the same.

An instructive example of the lack of an effective cost-keeping system was the experience of a contracting company, which went into voluntary liquidation on the conclusion of thier sixth contract, pocketing a net loss of about $30,000. They executed a contract for about 25 miles of heavy road grading and masonry, on which work they employed three auditing accountants under a treasurer or paymaster, who was an expert accountant. They were supplied with a large number of special blank forms and books, for the purpose of keeping a full distribution of costs. Owing to "the pressure of other work" these forms and books largely remained blank, and if they had not, it is doubtful if they could ever have been made to disclose much information of value. The "system" was top heavy and was not at all adapted to the conditions or to the work. When this work was nearly completed, the managing director of the contracting company came to the conclusion that the engineers were not giving them, in their estimates, either the quantities or the classification which they had earned.

They thereupon employed an engineer to go over the work and make up a complete estimate. They were fortunate in being able to secure a set of the original cross sections, which are often withheld from the contractor, particularly when a dispute is in prospect. The result of this remeasurement showed that the work had been underestimated by nearly $20,000, mostly in quantities but partly in classification. To avoid a lawsuit, they accepted a settlement of about 60 per cent. of their just claims. On items where they could show actual and accurate measurements, their claims were allowed, and these included an increase of $5,000 in quantities for seven-eighths of a mile of solid rock excavation.

The conclusions to be drawn from this are:—First, if they had employed an engineer to make independent measurements and estimates from the very beginning of the work, they would very likely have secured about $8,000 more in the final settlement. Second, the differences could have been largely settled each month instead of at the end of two years, at which time many things were forgotten and witnesses out of reach. Third, that a cost-keeping system on general contract work should include a system of independent monthly measurements and estimates. Fourth, that on grading and similar work, the contractor should secure the original cross sections before opening up or disturbing the surface or ground.

The fourth conclusion may be more clearly brought out by relating an incident in a suit of a contractor against a railroad company for about $100,000, on the claim that the engineers of the railroad company had underestimated his work by that amount on two very heavy sections. He produced as witnesses several engineers who had cross-sectioned the work several years after its conclusion, and who substantiated his claim. The railroad company, in defence, submitted the notes of the original cross sections, which showed that, on the two sections concerned, the line followed an old grade which had been excavated some 30 years previous to the time in question. If this contractor had kept even approximate notes of the original cross sections, he would never have incurred the expense and trouble of bringing suit on such a claim.

While considerable losses may sometimes be saved in final settlements by adequate records of costs and quantities, this should be considered only a secondary or incidental result, the principal and most profitable object being to locate wastes and inefficient expenditures in the beginning, so that they can be corrected and the leaks stopped. In the illustration cited above, where independent monthly measurements and estimates would probably have saved $8,000 to the contracting company, a cost-keeping system could have been carried along with the monthly estimates, without materially adding to the expense, which would have saved them over $20,000 by promptly pointing out where the leaks occurred.

Cost-keeping systems on contract work should generally be devised with both of these objects in view, as they naturally go together.

Young engineers, with a few years' experience, should usually be found to be well qualified for the work, under the direction of an experienced manager. If proper managerial direction is lacking, more experienced men will be required. Other things being equal, men with a technical training should be able to bring to the task a mental equipment by which the maximum of results may be obtained at a minimum of expenditure.

Distributions of cost require a record of the quantities to which they refer, and therefore the measurements and estimates must be taken for the same periods that the distributions are desired to cover; --weekly, bi-monhly or monthly. Engineers' monthly estimates will generally be found unsatisfactory, if not wholly useless for this purpose, not being properly segregated in detail for the purpose of cost distribution. The work of making independent measurements and estimates is not difficult when properly attacked, and it can easily be carried along with the cost keeping. If the man in charge of the cost keeping has some engineering training, little or no additional cost will be incurred. The value of independent measurements and estimates to the contractor is, for many cases, almost self-evident.

A very great saving in labor and cost will often result from the use of approximate measurements and methods in preparing the partial estimates of work done for any short period. The resulting cost per unit of quantities will be sufficiently accurate for all practical purposes, and can be made available for the use of the manager much sooner than where exact or precise methods are used. Approximations must always be used with judgment, or they will not be safe, and their limit of error or degree of accuracy should be established closely.

The value of a cost-keeping system decreases as the time required to work out the results increases. If the manager or superintendent could know on Monday morning just what his unit costs were for the past week, he could make better use of the information than if it was not available until a month later. A successful contractor once said, "I cannot get my costs in time to use in making up my bids for work in the following year." The value of his cost keeping was evidently only historic. Even if the costs on one piece of work are only obtained in time to use in preparing the next bid, the results are of somewhat doubtful value. What we would like is, to know today what it cost, for instance, to lay concrete per cubic yard yesterday; how much for materials, for handling, for mixing, for placing, for forms, for power, for plant, etc. But this would be ideal and far better than we can hope to accomplish. A practical and reasonable rule would be to have the unit costs in detail tabulated for use within 48 hours to four days after the close of the last day's work of each weekly, fortnightly, or monthly pay-roll period.

In some cases it may be found desirable to have the unit costs computed and tabulated for each calendar month, in which case several pay rolls, or parts of pay rolls, would generally be included. With a complete system and modern tabulating and computing facilities, unit costs can be computed without reference to the pay-roll periods. Special reports can be quickly made at any time and covering any part of the work or period of time.

It is expected to follow this with articles descriptive of systems actually used, and outlining a complete system employing the readily available modern ideas and appliances.

EDITORIAL COMMENT

IT is hinted in well informed circles in Washington (and elsewhere) that if the suddenly prominent enthusiasm for a sea-level canal at Panama were traced back to its ultimate sources, some of these might be found to be of very doubtful purity—or, rather, of very definite impurity. This is not by any means to say that there is not a sincere and honest party in favor of that plan. Let us hasten, in all frank, ness and courtesy, to acknowledge the good faith and the ability of many of its supporters, and the weight of some of their arguments. But the statement is made, apparently with much to support it, that the livery of this party has been seized as a cloak by wholly selfish interests whose sole purpose is to delay as long as possible the completion of any canal connecting the oceans.

It is earnestly asserted, in short, that the sea-level proposition has received its most specious presentation through the influence of a certain *claque*, whose mission it is to work up an apparent popular enthusiasm for a project which will involve long preliminary discussion, the delay and uncertainty of wholly new plans, and finally the maximum of time for construction and opening of the canal. The interests (so it is said) which first fought bitterly against any canal at all, and then covertly for an impracticable location for a canal, are now fighting craftily for a type of canal which will delay the opening and give them an extension of their monopoly for full ten years longer than they would retain it if the lock canal were built. These interests are the Transcontinental railroads.

* * *

IN connection with the present interest in the question of accidents on railways there has been shown a tendency to compare the methods of investigating disasters and reporting accidents in Great Britain with those existing in America, and in some quarters the reports of the Interstate Commerce Commission upon accidents have been rather severely criticized.

It is impossible to compare the reports of the Interstate Commerce Commission with those of the Board of Trade, simply because the conditions under which the two bodies act are not the same. That the methods of the Board of Trade are not perfect may well be admitted, but that they are superior to those of the Interstate Commerce Commission has been maintained by some who deplore the present agitation about accidents on American railroads. For this reason it may be of interest to note the extent to which the powers of the Board of Trade exceed those of the Commission. Thus, in connection with its supervisory powers over British railways, the plans for any railway construction are required to be deposited with the Board of Trade before any bill can be introduced into Parliament; and before any railway can be opened for traffic the permission of the Board must be obtained, on the report of an inspector. Since the block system is compulsory in England, this portion of the equipment is included in the inspection, the entire signal system and interlocking plant being subject to the approval of the Board of Trade, after a report by its inspectors. The railways are required to give notice to the Board upon the occurrence of any accident, and all the circumstances must be placed fully before an inspector of the Board, sent to the spot for the purpose; and on the report of this inspector the Board is empowered to take such steps as may be judged necessary for the security of the public.

American railroads would probably make serious objections to the granting of such powers to any official body, but that they have made for safety in England seems to be beyond denial, and with such an example before us we can scarcely plead ignorance of at least one way to reduce the number of railroad accidents.

* * *

THE approaching International Railway Congress at Washington will doubtless result in much good in connection with the interchange of opinions and experience in various departments of railway construction and operation. Among the points to be considered it is to be hoped that the question of standard rail sections, material, and methods of testing will have a place. As was long ago pointed out by Mr. James W. See, in a paper on standards, presented before the American Society of Mechanical Engineers, the acceptance of a standard does not necessarily mean that anybody is obliged to conform to it, but merely that it becomes a definite and accessible record, which can be used in framing a specification or in establishing an agreement without the necessity of redescribing what has already been precisely described and recorded.

At the present time there are a number of specifications and sections for rails which differ but slightly in minor matters, and which might well be discussed in the hope that fruitful and useful suggestions may be brought forth from men who, above all others, are best fitted to treat the questions included.

* * *

THE interesting figures of the increase of road-repair costs under motor-vehicle traffic, given by Monsieur Périssé on pages 901-903 of this number, bring out again a very important point which was well put in Col. Sylvester Stewart's article in our issue of July, 1903. It is often overlooked in the comparison of various modes of transport, with the result that the inquirer is led to false conclusions. Briefly, it is that the moving vehicle is only one element in the economy of transportation. The other, and really the more important in many respects, is the permanent way on which that vehicle runs. No concept of the subject is complete and no comparison true unless both of these factors are adequately rocognized and given their proper proportionate value. The question "what will be the place of the automobile in the civilization of the future?" is inseparable from the question "what will be the roads of the future?"

With Col. Stewart's permission, we quote from a recent letter received from him :—

> "On pages 118, 119, and 121 of 'Modern Industrial Progress,' just issued, the distinguished author has done me the honor to quote at considerable length from my article in THE ENGINEERING MAGAZINE on 'The Automobile and the Railway as Transport Agents,' but he thinks that greater changes than I anticipate will occur in five hundred years.
>
> "Five-hundred years, however, will make no change in the composition of materials. Sugar will still be sweet and vinegar sour, and steel roads will still be smoother, stronger, and more durable than stone; from which smoothness, strength, and durability result the advantages I pointed out."

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

RAILWAY ACCIDENTS IN ENGLAND AND AMERICA.

AN EXAMINATION OF AMERICAN AND BRITISH REPORTS ON RAILWAY ACCIDENTS AND THE CONCLUSIONS WHICH CAN BE DRAWN FROM THEM.

Slason Thompson—Western Railway Club.

THERE is no question, at the present time, as to the interest which is taken by nearly everyone in the question of accidents on railways; and on the part of Government officials, railroad authorities, and the traveling public the subject is admitted to be one for discussion, study, and action. The paper of Mr. Haskell, published in the December issue of this Magazine, together with the reports of the Interstate Commerce Commission, have attracted wide attention, and there is ample evidence that the agitation will continue until some remedial action is taken to diminish the number of casualties, especially on American railroads.

In such a matter it is most important that any premises should be founded upon accurate and reliable information, and especially that any attempts at comparisons between the conditions in different countries should be based upon data which are strictly comparable. This side of the question has been brought out by Mr. Slason Thompson in a paper presented before the Western Railway Club, and some abstract of his discussion is here given as bearing upon an important element in an important matter.

In the first place it is to be noted that comparisons are frequently made on one side between the number of accidents to passengers and the total number of accidents to all persons, employees included, on the other. Thus the report of the Board of Trade for 1901 showed that not a single passenger had been killed in a train accident in Great Britain, and this noteworthy fact has been compared with the great loss of life reported on American railroads. As a matter of fact, however, the same report of the Board of Trade showed that the total number of personal accidents during the same year on British railways amounted to 1,277 persons killed and 18,735 injured, these, however, not being passengers. Mr. Thompson very properly objects to a comparison of a part of the report of accidents on British railways with the total on American railroads.

The British reports include a classification of the character of the accidents, together with a comparison between the number of accidents and the corresponding number of persons exposed to accident as well as a review of the tendency of accidents to increase or diminish. It is intended also to distinguish between preventable and non-preventable accidents, the whole intent being the collection of information, not for the mere sake of publicity, but principally with a view of determining the best methods of diminishing the number of accidents of all kinds in connection with railway operation: The work of the Board of Trade in this connection is in the hands of a special department, the inspection staff being composed almost entirely of officers of the Royal Engineers. It must be remembered that the Board of Trade is a Department of the Government, with extensive supervisory power over the conduct and operation of railways, such as would seem very onerous in the United States, and among these powers is included the inspection of all railway accidents, the railways being required to give notice in every case of accident, sending for an inspector, whose report is made the occasion of the exercise by the Board of its power to take such steps as are necessary, in its judgment, to provide for the security of the public.

It has been maintained that, in any comparison between British and American railways, the difference in mileage should be taken into account, but this seems hardly a correct basis for comparison, and a more rational one would appear to be the number of passengers carried, although the connection in this case is by no means positive. The great disparity between the number of passengers and the number of employees killed is in itself an indication of the greater degree of relative risk in the latter case, and indeed this feature is emphasized by the fact that some accident insurance companies give increased indemnity to policy holders who may be injured while traveling in public conveyances, thus distinctly recognizing that the individual is safer in the car than elsewhere. It is therefore most desirable that the reports of the Interstate Commerce Commission should so classify the accidents as to enable the separation of passengers from employees, and especially to indicate the nature of the accidents by which so large a number of employees are injured. It is hardly to be expected that this latter information could be obtained from the railroad companies, but if the Interstate Commerce Commission were given the same powers as the Board of Trade in this respect, a long step forward would be taken toward making the two reports comparable.

An interesting statement in Mr. Thompson's paper appears when he makes the following remarks about block systems:

"The accident reports of the Interstate Commerce Commission, prejudiced as they are in favor of the block signal system as the panacea for railway accidents, cannot wholly conceal the fact that recklessness, negligence, and disobedience in the human equation is mainly to blame for railway accidents. In three cases out of four where the block system is installed the failure of the human equation to keep it in order, or to observe or to obey its warnings, neutralizes its efficiency. The inevitable tendency of the block signal system is to beget carelessness in the train crews, as it shifts responsibility to the signal system operators or to the signal itself."

The best comment which can be made upon this statement is that given in the discussion by Mr. Tratman, which we here quote:

"Mr. Thompson states that, in his opinion, the absence of safety devices has little to do with safety in operation, and that recklessness, negligence, and disobedience in the human equation are mainly to blame for railway accidents. He states further that he approves of block signals wherever practicable, and where they will insure public safety without overburdening public traffic (evidently failing to realize that the block system is an aid to the prompt and efficient handling of traffic). But in the next sentence he says the inevitable tendency of the block signal system is to beget carelessness in the train crews. If this 'inevitable tendency' exists it is difficult to see why Mr. Thompson should favor the system at all, but as a matter of fact this 'tendency' is imaginary.

"In England the railway system has nearly the entire mileage (and certainly all of its main-line mileage) operated under the block system, subject to the rules of the Board of Trade. If English railways had the same small percentage of length equipped with block signals as in this country, the accident list would undoubtedly be very much larger. In fact, with the density of traffic of English railways it would be impossible to handle the train service safely or efficiently without the block system. In England, the use of the block system is compulsory, and no railway can be opened for traffic until its track and equipment (including signals and interlocking plants) have been inspected and approved by the railway department of the Board of Trade. As to discipline, it is well known that English railway employees are less apt to disobey orders and signals or to take chances than are the employees of American railways. This is largely due to the fact that the former have for years been trained to observe and obey signals implicitly as their main guidance in running the trains."

It should hardly be necessary to observe that the real responsibility is a matter which lies higher up than with the train crew, and that a part of the duty of officials in charge of the conduct of transportation is the enforcement of the operation of signalling systems as well as of their installation. No military officer would think of endeavoring to shift the responsibility of matters entrusted to his command to the shoulders of his inferiors, and it should be well understood that the acceptance of responsibility is the real attribute of high office.

Many years ago there was much the same sort of agitation in England concerning railway accidents as now appears in the United States, and it was then that Leech's famous cartoon appeared in ***Punch***, showing that the proper way to prevent accidents on railroads was to lash a director of the company to the front of each locomotive. England has benefited by that agitation by the enactment of the very powers for the Board of Trade to which Mr. Thompson has so fully referred, and the lesson is one by which America may also learn what is best to be done.

MAIN-LINE ELECTRIC TRACTION.

AN ARGUMENT FOR THE REPLACEMENT OF STEAM LOCOMOTIVES BY ELECTRIC TRACTION FOR THE HEAVIEST FREIGHT SERVICE.

H. Ward Leonard—Electrical World and Engineer.

ONE of the most difficult things to obtain, in considering the replacement of a process, method, or line of business conduct by something new, is the establishment of a correct basis of comparison. In nearly every instance the existing thing is used as the standard and the proposed plan is compared with it, usually upon some selected line, such as gross cost, equality of capacity, or some partial consideration, according to the ability or prejudices of the person having the matter under consideration. As a matter of fact this is not the way that changes are really made, and, indeed, great alterations in the conduct of important enterprises are rarely made as a consequence of deliberate aforethought, but usually follow as the result of a slowly accumulating external pressure which ultimately becomes too great to be resisted.

In the case of the comparison between steam and electric locomotives for main-line service the basis usually taken has been the cost of conducting the traffic with the present equipment, and when it has been shown that little or no gain would result in doing the same work in the same way, merely substituting electricity for steam as a source of power, the question is complacently assumed to have been answered. The absurdity of such a method readily appears if it is compared with changes which have really been accomplished. Thus, for example, any attempt to have considered the relative values of steam railways and with the former system of stage coaches and horse-drawn teams, by examining the cost of doing the same work as was performed by the horses, if steam power were substituted, would have shown an enormous increase in the capital invested, and a far larger operative cost. In like manner the cost of propelling a vessel by steam as compared with the use of wind power for the same displacement and speed would make but a sorry showing for the steamship. Trolley cars of the same size, weight, speed, and number as the old horse cars of any street railway system, would prove a costly and unprofitable substitute, and so with any other transformation which might be cited.

These thoughts are brought out in connection with an article by Mr. H. Ward Leonard in a recent issue of the *Electrical World and Engineer,* in connection with the discussion of the probable substitution of electricity for steam for hauling freight on main-line railways.

Railway men are all fully impressed with the fact that the freight receipts depend upon the ton-mile, and that the expenditures are, under present conditions, a function of the train-mile, and under these circumstances they naturally bend their energies toward the increase of ton-miles and the reduction in train-mile costs. It is upon this entirely correct principle that Mr. Ward Leonard approaches the question, with the result that some very interesting conclusions appear.

In the first place it is increasingly evident that the limitations of the steam locomotive are being closely approached.

"A modern compound freight locomotive, which produces about 1,400 h. p. at 18 miles per hour, with a pull at the drawbar of 30,000 pounds, can produce as a maximum about 50,000 pounds drawbar pull, but to do so will have to reduce its speed to, say, three miles per hour, and will then produce only about 400 h. p.

"It is a most unfortunate fact for the steam locomotive that just when the heaviest grade is encountered and the demand exists for from three to six times the power required on the level in order to maintain sufficient speed to prevent traffic congestions, the power of the steam locomotive, instead of increasing in response to this temporary demand for increased power, actually falls to about one-third or one-half of its maximum power.

"The boiler is the limiting feature of the steam locomotive. There is a limit to the steam pressure which can be efficiently employed. There is a limit to the amount of coal which can be burned on the limited grate surface in the limited firebox. There is a limit to the work which the fireman, or even two firemen, can perform in stoking. All of these limits have been reached, or practically so, in the modern high-powered steam locomotive, and whatever this limit may be in favorable weather, it is again greatly reduced by conditions of extremely cold weather, when the reduced steaming capacity of the boiler, the reduced physical strength of the fireman and the bad track surface, all unfavorably affect the production of the increased horsepower needed to maintain schedule speed."

The compound system has extended somewhat the hauling capacity of engines by the higher efficiency with which the steam is used, but in the great engine exhibited at St. Louis, with 5,600 square feet of heating surface and about 2,500 horse power, the limitations are closely reached. The 80,000 pounds drawbar pull which this engine can exert is about all that existing equipments can stand.

It is evident that any system which is to supersede the steam locomotive for freight service must do much more than compete with that machine, it must take up the work where the steam locomotive is compelled to leave off. Freight must be hauled in longer trains, at higher speeds, and up steeper grades, if the cost per train-mile is to be further reduced, and upon the reduction in the train-mile cost to the railroad depends the reduction in the ton-mile charge to the shipper.

The fitness of the electric locomotive, operated in multiple unit, with as many locomotives to a train as may be necessary to do the work, is seen by the fact that the electrically propelled machine is capable of exerting a pull of 125 pounds on the drivers per horse power, while the maximum for the steam locomotive is about 117 pounds.

"Just as in the former street car practice a light car was essential when the power was limited to horses, and the horses laboriously moved the car on a 6 per cent. grade at a slow speed, so the modern steam locomotive, with its limited power, moves the relatively light freight train at a slow speed on the mountain grade, and just as the gigantic trolley car of to-day rushes at nearly full speed up a grade of 6 per cent. driven by a source of practically unlimited power and responding without injury to the demanded production for a short time of some six times the power needed on the level, so will the future electrically-driven freight train rush up the present mountain grades at a speed which will make the speed of to-day on mountain grades seem ridiculous.

"If one per cent of the money spent per annum in the reduction of grades and the strengthening of curves were spent in building electric locomotives and power plants to use them, where increased power is needed, most of the vast sums being blasted and shoveled away would be saved and a far better economical result would be obtained than can ever be hoped for by the use of steam locomotives.

"Let us now look briefly at the effect which would follow a possible reduction in the cost per ton-mile. Most people, no doubt, think that the cost of the ton-mile is a matter of little concern to them. The railways of the United States were paid by the inhabitants of the United States in 1903 for producing 173,221,000,000 ton-miles; that is, every man, woman and child in the United States paid to the railways, as an average, last year, the price of 2,160 ton-miles; 8 tons were moved over 250 miles for every inhabitant of the country. In 1893 the per capita production was only 1,430 ton-miles. In 1880 it was 645 ton-miles per capita.

"The inhabitants of the United States paid to the railways last year for freight transportation at least $1,320,000,000. It will be evident from these figures that the price paid to railways per ton-mile vitally affects the per capita income and wealth of this nation and a material reduction in the ton-mile selling price is an important source of wealth.

"To illustrate this the reader need only be reminded that the enormous wealth of the Standard Oil Company was built up out of a small percentage rebate on the ton-mile price.

"On account of competition the railways have thus far promptly given to the public most of the benefit due to savings effected in producing the ton-mile. In 1903 the average selling price of the ton-mile was .76 cent. In 1893 it was .88 cent. In 1890 it was .94 cent. The ton-mile price has, therefore, been reduced 20 per cent. since 1890. If the freight moved last year had been paid for at the rate which prevailed in 1890, the public would have paid to the railways last year $312,000,000 more than it actually did pay. This enormous annual saving is equivalent to dividing among the inhabitants of this country a dividend of 2½ per cent. upon the $12,600,000,000 of railway stocks and bonds outstanding in this country. It is practically equivalent to dividing among the inhabitants of the United States all the gold annually produced in the world.

"It seems safe to say that the most important factor in the recent enormous production of wealth in America has been the startling reduction in the price of the ton-mile.

"Enough has been said to make it clear that there is no subject in which the general public is more interested than in the cost of production of the ton-mile. It is hoped that sufficient evidence has been presented to make it clear that economies in the production of the ton-mile are radically influenced by the amount of power than can be commercially applied to a freight train."

It is evident that if the question of steam and electric traction for main-line railway service is to be considered intelligently it must be upon the basis, not of present conditions, but upon the extent to which electricity may be used to carry the train-mile capacity far beyond present limits, and thus reduce the cost of the ton-mile, both to the railroad and to the shipper.

THE ECONOMIC VALUE OF CAST IRON.

THE PRODUCTION OF MACHINE CASTINGS OF MAXIMUM STRENGTH, UNIFORMITY AND SATISFACTORY MACHINING QUALITIES.

W. H. Pretty—Manchester Association of Engineers.

IN these days of steel it is possible that insufficient attention is given to materials of construction which are still very largely employed, and which, if considered in the light of improved methods of production and operation are undoubtedly susceptible of partaking to a greater or lesser degree in the advantages of scientific manipulation. It is beginning to be acknowledged that for some purposes wrought iron is distinctly better than steel, and it must be admitted that cast iron is yet one of the most extensively used materials in the machine shop, and yet it is only recently that the foundry and its products have been given anything like the amount of scientific attention which has long been accepted in the manufacture and use of steel. In a paper recently presented before the Manchester Association of Engineers, Mr. W. H. Pretty discusses the economic value of cast iron in the light of present shop methods, and some abstract of the paper will be found of interest.

"The value of cast iron in the arts and manufactures of the world is such that it must necessarily take an important place in the great industrial questions of the day, while the vast supplies held in store for us by nature, of ores of iron and fuels, and sources of energy capable of being utilised for the production of heat by electrical or other means, are sufficient indication of its continued use by man in the future. It behooves us, therefore, as engineers to give the subject all the attention we can to develop it to the best of our ability, and endeavour to make the founder's work a sure science. The most important applications of cast iron (under which term is included pig-iron) at the present time may perhaps be broadly classed as follows:—

"(1) Its use in the production of wrought iron, steel and ingot iron, &c., essentially of a metallurgical nature.

"(2) Its use in the service of mankind by civil engineers and others for structural work, bridges, tunneling, pipe lines for water supply, and other purposes.

"(3) The production of castings for the general use of mechanical and electrical engineers in the construction of machinery, steam engines and other prime movers, &c.

"(4) The reproduction of works of art, ornamental ironwork, and various articles required for domestic and other purposes in times of peace.

"(5) The manufacture of malleable castings.

"The field covered is a very wide one, Class 2 is gradually passing into the hands of iron founders possessing blast furnaces, for obvious reasons, but is still practiced on a small scale by founders engaged in Class 3, while it would seem that Class 5 is likely to be replaced by steel castings."

The exact definition of the term cast iron is almost as difficult as the precise meaning of the term steel. According to Professor Howe cast iron is defined as iron containing more than 2 per cent. of carbon; just as he defines high-carbon steel as iron with a carbon content between 0.30 per cent. and 2.00 per cent., and low-carbon steel as iron containing less than 0.30 per cent. of carbon. Mr. Pretty is much less definite than this, as he broadly defines cast iron as iron, with the addition of small quantities of carbon, silicon, sulphur, phosphorus, manganese, and "anything else it can lay its hands on."

"Cast iron is frequently described as occupying a place in the iron carbon series, but it is something more than this, its composition is of an exceedingly complex nature and it should really be regarded as the product of a process in which other materials, in addition to iron are reduced by the action of fuel and blast and enter into combination with it. In addition to these we may have compounds formed without the direct reduction of the elements and it is not at all unreasonable to suppose that interchange between compounds and elements takes place in solution at high temperatures analogous to those we obtain in the chemical laboratory in solutions at normal temperature. It is customary today to judge the suitability of a pig iron for foundry purposes by the carbon, silicon, sulphur, phosphorus and manganese present. Before long we shall have to pay more attention to other elements such as chromium, arsenic, copper, titanium, etc., and their behaviour when in solution or combination with irons, in quantities so small that we to-day ignore them."

After enumerating the more frequently employed ores of iron, and the processes used in the production of pig iron, Mr. Pretty discusses the ordinary methods of grading and classifying the product. Formerly the old method of determining the character of the metal by the fracture of the pig was considered sufficient, but this can no longer be accepted. The increase in varieties together with the changes in structure due to the production of machine-moulded pigs cast in chills demand some more precise method, and the use of a combination of chemical analysis, united with physical and mechanical tests, must be advocated. Of course an accurate knowledge of the pig is by no means everything, since the advantages of the most careful choice of materials may be completely upset in the foundry by careless working at the cupola, the use of improper fluxing materials, blast conditions, casting temperatures, and other elements of manipulation.

There is no doubt that by the use of chemical and physical methods of examination, both as applied to the pig and to the resulting castings, the conditions giving any desired result may be discovered.

and a repetition of any determinate series of operations be made to give a desired product.

The present interest in the introduction of rapid machining processes, including high-speed steels for the cutting tools and more powerful machine tools in which to do the work, has emphasised the demand of the machine shop upon the foundry for soft and easy-cutting castings. As Mr. Pretty well says, however, the question arises, which is the more important factor, the economic value of the material, of the output of the machine departments? In many cases the strength is ample and the cost of machining is paramount, but there are many others in which the material must take premier position. Mechanical tests show conclusively that metal which would be hailed with delight and satisfaction on the shop because of its softness, may be unsuitable to meet the conditions of stress and wear which are to come upon the finished product. Mr. Pretty urges the importance of including among the tests for cast iron that of its machining quality, by the provision of test pieces to be subjected to the lathe and the drill, so that information upon this important class of properties may be included with those of resistance.

In this connection a form of standard test is given, readily available for trial in the lathe as well as in the drill-press and boring mill.

"To enumerate a few of the questions bearing upon the manipulation of cast iron throughout its treatment in the foundry we have:

"The formation of suitable slag in the cupola.

"The behaviour of the blast and possible occlusion of gases in the cupola under bad working conditions.

"The addition of minute quantities of reducing agents, such as ferro-aluminium, ferro-silicon, ferro-manganese, (silicon-aluminium-manganese alloys), etc., to the molten metal while in the ladle.

"The pouring temperature and the study of cooling curves by means of thermometers specially suitable for the work.

"The behaviour of moisture and gases at the high temperatures suddenly brought to bear upon them, and ranging from 15° C. to 1,600° C. or higher, and their behaviour when in a state of occlusion, solution or enclosure in a mass of cast iron, capable or incapable of yielding to the pressure produced.

"The occlusion of gases by molten cast iron and their retention or throwing off as the metal cools down to the solid state, and the effects of rapid cooling upon this phenomenon.

"The possible liberation of gases within the mass of molten metal as it cools down, and due to molecular and chemical change other than that accounted for by occlusion.

"The effects produced by various degrees of moisture in the sand composing the mould, upon the metal in contact with it. and methods of determining the percentage of moisture in the facing and other sands used in forming the moulds. The shrinkage of cast iron as it cools down from the molten state, and its sudden expansion when nearing the point of solidification, afterwards followed by the usual contraction of solids as its temperature falls.

"The remelting of foundry irons and the change in character of the chemical constituents, and means of remedying this as required.

"The diffusion of metals.

"The heat treatment of cast iron and molecular rearrangement.

"The decay of cast iron under various conditions of employment, and means of remedying this.

"The effect of casting temperatures upon special chilling work.

"The study of eutectic and other alloys within a mass of cast iron, and the physical changes which accompany them.

"The various types of furnaces in use for remelting pig irons for foundry purposes ,etc., and the nature of the blast capable of giving the best results."

In the United States the study of cast iron and of foundry work has been effectively conducted by the American Foundrymen's Association, and it is a matter for congratulation that a British Foundrymen's Association has recently been formed, since it is only by interested co-operation of the men who are actually doing the work that the same progress may be expected in this as has been made in other departments of metallurgical work.

THE STRENGTH OF CONCRETE.

EXPERIMENTAL RESEARCHES INTO THE RESISTANCE OF PLAIN AND REINFORCED CONCRETE TO VARIOUS STRESSES.

Professor Mörsch—Schweizerische Bauzeitung.

WITH the extending use of concrete in construction there has arisen a demand for later and more accurate information, both as to the resistance of the plain concrete itself and in connection with various methods of adding a metallic reinforcement. The technical journals have contained many articles, bristling with mathematical equations, and evolving elaborate formulas, while the amount of reliable data upon which these superstructures have been reared is comparatively small. For this reason every contribution to the moderate stock of reliable experimental knowledge in this important and increasing department of engineering work is to be welcomed.

In recent issues of the *Schweizerische Bauzeitung*, Professor Mörsch gives a very clear account of some experimental tests made by him, showing their connection to the theoretical relations actually existing in members of concrete and metal, in connection with shearing and crushing stresses.

The tests made by Professor Mörsch, made in the testing laboratory of the Stuttgart Polytechnic, took into account the fact that in actual practice, especially for beams, crushing and the shearing forces are of the utmost importance, and hence he conducted the experiments with a view of determining directly the resistance to shearing action, as well as to crushing.

Theoretically, it is common to consider the forces in single cross-section elements of a beam, but in actual work the forces are not constant for any portion of the cross section, and it is necessary to take into account the changing action upon the whole series of successive elements of the cross section of the beam under consideration.

Professor Mörsch describes a number of tests of the shearing resistance of plain concrete, using a Martens testing press, and comparing the results with tension and compression tests upon concrete of the same constitution and age. In the brief theoretical study preceding the discussion of the experiments, it was deduced that the resistance to shearing should be the square root of the product of the tensile and the compression resistances, and this simple rule was well confirmed by the trials. Thus, for a concrete of the proportion 1 : 3, with 14 per cent. water, the shearing resistance, after two years, was 65.9 kilogrammes per square centimetre. Tension and compression tests upon the same material, of the same age, gave a tension resistance of 15.5 kilogrammes, and a resistance to crushing of 308 kilogrammes per square centimetre. The square root of the product of these two results is 69 kilogrammes for the theoretical shearing resistance. In another test the shearing resistance was 37.1 kilogrammes, while the tensile and crushing strengths were 8.8 and 172 kilogrammes respectively; the square root of the product being 38.8 kilogrammes per square centimetre.

When similar beams, reinforced by the imbedding of round iron rods near the upper and lower surfaces, were subjected to test for direct shearing, it was observed that fine cracks appear at about the same loads as caused failure in the non-reinforced beam, but that these cracks did not increase rapidly with increase in stress, and that failure was attained only when the shearing resistance of the reinforcing metal was reached. In these tests the shearing resistance of the iron rods was taken as 0.8 of the actual tensile strength.

In addition to the direct shearing tests, Professor Mörsch conducted a number of torsion tests upon short cylindrical pieces, both solid and hollow, these including pieces of plain concrete as well as those reinforced with imbedded rods forming spirals or helices of an angle of 45 degrees. This form of reinforcement was adopted because it was indicated by the direction of the cracks appearing in the torsion tests on plain concrete cylinders.

In these tests the cracks appeared in the concrete when the tension on the imbedded rods reached about 16,500 pounds per square inch, this apparently being a point when the metal permitted the elastic limit of the concrete to be exceeded.

An interesting portion of the tests of Professor Mörsch was that upon the adhesion of imbedded metal rods and the concrete surrounding them. It has been assumed in some instances that the adhesion is proportional to the shearing resistance, probably upon the theory that the yielding takes place by the tearing of the concrete, a layer adhering to the metal. The experiments of Professor Mörsch, however, show that the resistance is the actual friction between the surfaces of the metal and the concrete, and that this depends upon the density of the concrete and upon the character of the surface of the metal. If the metal is rough, or of irregular form, and the concrete well rammed, the frictional resistance may exceed the shearing resistance, owing to the fact that hard pebbles, or other solid portions of the concrete become interlocked with the metal.

These experiments, conducted with a view of obtaining definite information, rather than with the intention of supporting any preconceived ideas, may be accepted as of material value in connection with an important and growing department of engineering construction, and it is only when theoretical investigations are based upon reliable data that practical and valuable results can be expected.

TELEPHONE LINE ENGINEERING.

MECHANICAL PROBLEMS CONNECTED WITH THE INTRODUCTION AND MAINTENANCE OF COMMUNICATION BY TELEPHONE.

C. J. H. Woodbury—Franklin Institute.

IN a paper recently presented before the Franklin Institute the problems of telephone-line maintenance were discussed by Mr. C. J. H. Woodbury in a manner well adapted to bring before the mind of the general reader the engineering features of a department of work concerning which there has been little published. The opportunities which are possessed by Mr. Woodbury for obtaining direct knowledge of the practical questions inseparably connected with the problem of telephone communication render his paper of much technical value as well as of popular interest.

By far the larger portion of the matter which has been published concerning the telephone is concerned either with the instruments of transmission and reception, or with the switchboard arrangements, but the fact that the very object of these terminal devices is the maintenance of communication over long distances makes it desirable that some attention should be given to the means by which those distances are spanned. At the present time there is in use in connection with the Bell telephone system in the United States approximately 4,000,000 miles of line construction, and when it is realized that this great investment is necessarily subjected to rapid depreciation, and that both for replacement and for continual extension ample provision must be made, some idea of the magnitude of the problem will be obtained. About forty-five per cent. of the Bell system's wires are on poles, and it is estimated that there are 6,300,000 poles in use, and that about 1,000,000 poles are required annually for replacements and extensions.

"The stresses to which a telephone pole is subject are the result of many and variable combinations of live and dead loads upon a beam fixed at one end and loaded near the other end. There is scarcely anything in engineering construction so actively the subject of depreciating conditions. The top is exposed to the weather, and the important section near the surface of the ground is the portion most energetically attacked by decay. The wood is assailed by animal life, whether it be gnawing by horses in town, or the perforation by woodpeckers in remote districts. Poles in wild countries are bitten by bears in search of bees, whose humming is imitated by the vibration of wires, and it is said that in India the tigers use the poles to sharpen their claws upon after the manner of their second cousins, the domestic cat, but with so much more vigor that the poles become weakened."

Apart from the questions of endurance to climatic and general depreciation, and to the fixed stresses which are thus indicated there are varying and uncertain stresses for which provision must be made.

"A pole line is not designed merely on the basis of the stresses to which the pole is subjected in drawing the wires to the necessary tension, for in most northern climates the sleet will at times form upon the wires until they become icy cylinders perhaps three inches in diameter, and the problem is not that of the mere added weight, for the force of the wind blowing against this icy sail applies a greater horizontal load, which combines with gravity and produces a resultant force in a diagonal direction, greater than either of the contributing units.

"An ice-laden line swayed by the wind may be successfully resisted by the poles until the oscillations of the pendulum reach a synchronism with that of the vibration of some pole on the line which responds in like manner to the cumulative impact across the direction of the line, until it breaks this individual pole. Then adjacent poles are relieved of the pull on one side, and the excessive unbalanced stress breaks them.

"The most undesirable occurrences in connection with the wreckage of aerial lines are the disturbances resulting from the contacts of different electrical systems with each other, when the various lines are so near as to collide, when one or both break."

Passing to the wires themselves, Mr. Woodbury gives a general idea of the manner in which the stresses depend upon the form of the catenary curve assumed.

"The tension on a line suspended between a pair of horizontal supports varies with the sag and is at a minimum when the sag amounts to seven-twentieths of the span, and the tension increases whether the sag is greater or less than this proportion.

"For example, with No. 12 hard-drawn copper wire, weighing 173 pounds to the mile, and being 0.104 inch diameter, and having a span of 130 feet, the minimum tension of three pounds would occur if the sag was forty-three feet six inches, while it would slowly augment with increase in the sag, and if nature had furnished a chasm deep enough for the experiment, it would be expected to reach its breaking tension of 550 pounds at a depth of 16,470 feet, or 3.17 miles.

"On the other hand, the increase in tension proceeds rapidly as the wire is drawn to approach a straight line, the breaking tension occurring at a sag of one and one-half inches.

"As a comparison with this instance of the stresses in a local line, in the case of the No. 8 hard-drawn copper wire, 0.165 inch in diameter and weighing 435 pounds to the mile, as used on long-distance telephone lines, when the span is 150 feet the minimum tension occurs at a dip of fifty-two feet six inches, when it is only eight and three-fourths pounds, and in like manner, as in the foregoing instance, its breaking stress of 1,328 pounds would be reached at the slightly less dip of 16,100 feet, or 3.04 miles, still too great to admit of confirmation by direct experiment; but if the wire was pulled until the sag was 2.2 inches, it would require the breaking load of 1,328 pounds.

"It is desirable that the wires should be drawn tight enough to prevent them from swaying against each other; but it is important that they should not be drawn so tight that the contraction during extreme cold weather should cause the wire to break."

Mr. Woodbury refers to the Doolittle method of producing hard drawn copper wire, in which the omission of the annealing process during the latter portion of the drawing operation overcomes the lack of resilience, and prevents the continual stretching which otherwise renders copper unsuitable for overhead work. Since the value of copper scrap is only two cents a pound less than that of new copper there is a commercial advantage in its use over galvanized iron wire, which costs four cents a pound and has no scrap value.

The greatest difficulties in telephone line construction are naturally met in the mountain ranges of the Western States, and the combination of rough valleys, high elevations, snow, ice, and avalanches renders this portion of the work of the telephone engineer most difficult. These lines are frequently charged with atmospheric electricity which must be discharged to the earth by bridging retardation coils across the lines and grounding the central part of the coils.

The actual gain in time by the use of the telephone for long distance communication appears in the statement of the fact that the actual time for the transmission by telephone between Boston and Chicago, a distance of 1,064 miles, is 0.006 second, while during the same time the voice is transmitted through the air but six and one-half feet.

The use of underground conduits in cities avoids many of the difficulties encountered with overhead wires, but they also have their share of mishaps. Thus the leakage of water and gas are both liable to produce serious results, while other underground work may cause serious interruptions and troubles. Still the underground system is well adapted for city use that fifty-five per cent. of the telephone-exchange wires are underground, and the number of wires in the conduits, in comparison with those upon poles, makes the number of miles of pole lines throughout the country seventy times the length of the streets occupied by the underground conduits.

At the present time there are more than 26,000 different settlements in the United States which are knit together by telephone communication, and the growth is continuous.

"During the last five years the number of telephones in the system has increased at a greater rate than ever before. This increase has been building upon itself like compound interest at the usurious rate of twenty-nine per cent. a year, and compounding each year at this rate would double the number in two and three-fourths years, or the number of telephones has actually increased over three and one-half times during the last five years.

"Each of these instruments as soon as installed comes into full service for connection with other instruments, and thus reciprocally each new telephone adds to the availability and, therefore, the value of those with which it may be in communication."

MECHANICAL CANAL LIFTS.

THE COMPETITION FOR IMPROVED METHODS OF OVERCOMING DIFFERENCES IN LEVEL ON THE LINE OF THE DANUBE-ODER CANAL.

Oesterreichische Wochenschrift für den Oeffentlichen Baudienst.

THE hydraulic canal lock is said to have been invented by the brothers Dionisio and Pietro Domenico, of Viterbo, in Italy, in the year 1481, a lock chamber with gates having been built by them in that year on the Piovego, a canal extending from Padua to Stra, and the device was promptly taken up by Leonardo da Vinci, who built six such locks on the Milan canals in 1497, after which the use of locks became general all over Italy and from thence in other parts of Europe. For nearly four hundred years no material improvement was made in the operation of raising and lowering canal boats, but with the development of internal waterways, and the inclusion of large differences in level, other methods have been devised. We have already noticed in these columns the hydraulic canal lift recently erected at Peterborough, on the line of the Trent canal, in Canada, this being the latest successor of the lifts at La Louvière, in Belgium, Les Fontinettes, in France, Henrichenberg, in Germany, and at Anderton, in England.

In the course of the plans for the proposed canal to unite the Danube and the Oder into one continuous waterway, it has been found desirable to arrange for a lift of 35.9 metres, or about 118 feet, at Aujezd, near Prerau, in Austria, and before deciding as to the best method of overcoming this elevation it was decided to institute a competition, open to engineers of all countries. No fewer than 204 designs were submitted in this competition, and the character of the premiated designs gives them especial importance in view of the increasing interest which is felt at the present time in the development of internal waterways in various parts of the world. In recent issues of the *Oesterreichische Wochenschrift für den Oeffentlichen Baudienst* the successful plans are illustrated and discussed at length, and some abstract of the principal features is here given.

The design receiving the first prize belongs to the inclined-plane class, but at the same time it includes a number of characteristic features. The design includes a double-track inclined plane, with a slope of 1 in 25, the canal boats to be hauled up and lowered in tank cars containing sufficient water to float them, although the arrangement is also applicable to the hauling of the boats themselves directly upon dry cars, should this be found preferable. The arrangement differs from other inclined-plane systems in that there is no direct mechanical connection between the two cars, such as a cable, or other positive device, a form of electric balancing being employed instead, this leaving each car independent as to its own movements. The tank cars are each equipped with two electric-motor propelling cars, these being provided with two motors each, the motor cars forming a portion of the suspension of the lower portion of the tank cars, practically permitting the whole load to be pushed up the incline and held back during the descent. The continuous current motors are so arranged that they act as generators during the descent, thus returning to the system an amount of energy equivalent to that required for the ascent. The motors act, by a system of gearing, upon a gear-wheel and rack placed between the rails, in a manner similar to that successfully employed upon many mountain railways. The arrangements for receiving and discharging the boats are similar to those already employed with success in the hydraulic canal lifts, with special rubber packing for securing water-tight joints about the doors.

The inside dimensions of the travelling tanks are 71.21 metres long, 8.8 metres wide, and 3 metres deep, or about 233 by 29 by 10 feet, and it is estimated that the ascent of 118 feet, up an incline of nearly 3,200 feet in length, will be effected in 29 minutes. The plan includes a large number of details which appear to be very completely worked out, the various portions of the design, while submitted as a single plan in the competition, being due to such responsible establishments as the Bohemian-Moravian Machine Works, of Prague; Messrs. Breitfeld, Danek & Co., of Prague; Ruston & Co., of Prague; Ringhoffer, of Smichov; the Skodawerke, of Pilsen, and the Austrian Siemens-Schuckert Company, of Vienna.

The second prize design is marked by great boldness and originality, but the standing and responsibility of its sponsors, and the completeness with which it has been worked out cause it to demand attention and respect. This is nothing less than the use of a great revolving drum, made of a steel framework, and greater in diameter than the total height of the lift, besides being of sufficient length and strength to carry near its periphery two opposite tank cylinders large enough to receive the canal boats. The whole device resembles somewhat the Ferris Wheel at the Chicago Exposition, lengthened out into a cylinder, and it will be seen that a half-revolution of such a drum would raise a boat from the lower to the upper position, the height being limited only by the diameter of the cylinder. The design submitted in the competition involves a drum 52.6 metres (172.5 feet) in diameter, and 70 metres (229.6 feet) in length, this being large enough to raise boats 225 feet long by 26 feet wide, over the difference in level of 118 feet required by the conditions of the competition. These dimensions are quite within present experience, the Ferris wheel being 250 feet in diameter, and the lengthening adding to the stiffness of the construction without introducing any structural difficulties.

The large drum is supported by floating in the lower dock from which the canal boats are to be lifted, the journals at each end serving only to steady and guide the whole during the revolution.

The drum is driven by gearing around the periphery, using electric transmission from a power house in which it is proposed to use Diesel motors as prime movers. The power required is only that necessary to overcome the frictional and inertia resistances, as the whole affair is always in balance, the weight of the opposing boats and tanks being always equal. The usual water-tight doors are required for the boat tanks and for the upper canal terminal, but not for the lower, as the main drum is immersed in the lower terminal chamber, and the boats can there be floated directly in. The details appear to be well worked out, and the estimated time of the operation of lifting is placed at 24 minutes for a single lift, of which eight minutes only are required for the actual lift, the remainder being required for the terminal building.

The authors of this ingenious design are engineers August Umlauf and Ludwig Ritter v. Stockert, of Vienna; Baurat C. Offerman, of Berlin; the Austrian Siemens-Schuckert Works, of Vienna; the Andritz Machine Works; and the United Augsburg and Nürnberg Machine Works.

These two projects are of much interest, both as indicating the extent to which plans have gone in producing substitutes for the ordinary canal lock, and also because neither of the prize designs are of the hydraulic-plunger lift type hitherto adopted for such work. Whether either design will ever be actually executed will probably depend upon other matters connected with the construction of the Danube-Oder canal, but both are most suggestive, and may serve as models for use elsewhere.

HOISTING PROBLEMS IN MINING.

MACHINERY AND METHODS OF RAISING ORE FROM THE DEEP SHAFTS OF THE LAKE SUPERIOR MINING REGION.

James R. Thompson—Lake Superior Mining Institute.

SEVERAL months ago we reviewed in these pages the paper by Mr. Hans C. Behr upon winding plants for deep mines, this paper having been presented before both the Institution of Mining and Metallurgy in London and the South African Association of Engineers at Johannesburg, and receiving an animated discussion in both places. This paper naturally dealt mainly with the problems to be met in South Africa, and it finds a fitting supplement in a paper presented before the Lake Superior Mining Institute by Mr. James R. Thompson, since this latter deals with the practice of the mining region about the Great Lakes of America.

Starting with the fundamental principle that the direct productive work of a mine is done underground, it follows that the arrangement of all other details should be based upon their influence upon underground efficiency. Viewed in this manner, it follows that in hoisting the speed is of first importance.

"Hoisting practice on Lake Superior largely, but perhaps unconsciously, conforms to a certain standard of speed. This standard may be stated as follows: No matter what the depth, the load must be hoisted from the bottom of the mine within one minute, and the round trip must take not more than two and one-half to three minutes. This seems arbitrary enough, but the fact is, that the second-motion hoists installed at the iron mines of from 300 to 800 ft. depth have roughly conformed to it no less than the big Nordberg quadruple engine at the Tamarack, with its 25½-ft. drum, hoisting from approximately 5,000 ft., and making from 18 to 20 trips per hour. A duplicate of this hoist is now being installed, a fact which speaks for itself. It is on record that a hoist at the De Beers mine, at Kimberley, has made 46 round trips in one hour per single skip, and has maintained an average of 32 round trips per hour for 24 hours from a depth of 1,260 ft. A first-motion hoist, with 12-ft. drums, installed some fifteen years ago at an iron mine about 500 ft. deep, could undoubtedly, if it actually did not, exceed that record. That such a speed of hoisting is unnecessary and excessive is indicated by the fact that a plant recently installed at the same iron mine, to meet the same conditions, has drums but six feet in diameter instead of twelve. Coal mines, which usually screen their product at the top of the shaft, are apt to serve a large territory by one shaft, and with lighter loads hoist more rapidly, often reaching the rate of a round trip per minute from a depth of 500 or 600 ft. It might be expected that the large iron mines, especially as they gain depth, would reduce the number of operating shafts and require a more rapid rate of hoisting; however, observation of the shafts projected, and the hoisting facilities planned, leads to the conclusion that the rate of hoisting quoted will suffice to dispose of the required production."

The question of speed hoisting is not necessarily limited to the lineal speed of travel, since it really means the speed of transport of material to the surface, and this is dependent upon the size of load as well as upon the rapidity of its movement. In the early days of shallow mines a single ton was considered a fair load, while now the loads are 5 tons in the iron mines and 7½ tons in the copper district. In general the requirements are that the load must be hoisted in one minute and a round trip made in three minutes, regardless of the magnitude of the load.

Such conditions as these are naturally severe upon both winding machinery and power plant. The tendency in the latter department is toward an increase in steam pressure, 150 pounds being now used as compared with 100 pounds formerly. In like manner it is being found better to attain high winding speeds by the use of smaller drums at higher rotative speeds, than to employ the large drums, since the quick running enables smaller, lighter engines to develop the same amount of power, effecting a material reduction in first cost. So far as the question of steam economy is concerned, however, altogether different elements are to be considered than in the case of a stationary power plant.

"Where steady power is required, the advisability of installing compound-condensing or triple-expansion-condensing engines is unquestioned. The duty required of a hoisting plant, however, is peculiar, and the ordinary treatment does not necessarily fit the case. The load upon a hoisting engine consists of the weight of the ore, which is the total live load, the weight of the cage, car or skip, which is a constant dead load, and the weight of the rope, an important percentage of the whole, which is a dead load continually varying in amount, being greatest at the beginning of the trip and nothing at the end. Added to this variable and largely unprofitable loading of the engines is the extremely intermittent character of the service required. The engines must start the maximum load, attain full speed in six or seven revolutions, hoist a continually decreasing load to the surface and stop short—all within one minute, and after a longer or shorter period of idleness, they must repeat the operation. Under such conditions the ordinary methods of obtaining economy of operation in steam-engine practice are insufficient, if not positively worthless. Lake Superior experience has fully demonstrated that a simple Corliss or other automatic variable cut-off gives more economical results than a slide valve or fixed cut-off, and engines of such design have been adopted at deep mines. The results of the attempt to gain a still greater economy of operation by the use of compound or triple-expansion engines are indefinite, if not negative. The subject is one of practical difficulty, for the reason that no one knows definitely what steam is required by the various types of engines in actual hoisting service. Even the compound and triple engines must use steam non-expansively to start and rapidly accelerate the load, and as different plants, and, indeed, the same plant at different times, are handling loads which vary greatly in the proportion between the live and dead loads, it is impossible to estimate the steam consumption in the ordinary method. The boilers supplying steam for hoisting usually also supply steam for pumping, air-compressing and other purposes, which renders it impossible to determine directly just the amount of coal to be charged to the hoisting. Even if this could be done, two plants are rarely to be found working under conditions sufficiently alike to render an accurate and reliable comparison possible."

In this connection it is interesting to note that it is to just such conditions as these that the Rateau steam accumulator has been applied with success, the irregular flow of steam from the main engines being equalized by the accumulator, and a large proportion of the power recovered by means of a low-pressure steam turbine. This method has shown its practicability in France, and its application is at once simpler and more satisfactory than any attempt to use a multiple-expansion engine under conditions for which it is unsuited.

In regard to the operation of hoisting itself, the principal question is that of balancing. With deep hoists the weight of the rope is an important element frequently equalling that of the useful load to be hoisted. The cars and cages are also included in the dead load, but these are constant, and in the case of a double hoist the two cages and their dead loads balance each other. The weight of the rope, however, is variable, and ranges from a maximum when the cage is at the bottom, to zero when it is at the top. The most complete balance is obtained by attaching a balance rope to the bottoms of the skips, extending from one skip to the other around a pulley placed at the bottom of the shaft.

"From the standpoint of the purchaser, the following conclusions may be drawn as to the requirements to be met by an ideal modern hoisting plant. It should use at least 150 lb. of steam pressure, because of the smaller size and cost of engines then required, and the fuel economy resulting. It should hoist the load from the bottom in one minute, and make a round trip in less than three minutes, no matter what the load or depth of shaft. The net load should be as large as possible in proportion to the dead load, and the mass of moving machinery should be kept as small as possible. The most perfect plan of balancing feasible under the individual circumstances should be used. A plain Corliss or other automatic, variable cut-off engine is best, and it is desirable to use engines of as high rotative speed as is found practicable in other lines of engine practice. The drums should be as small as possible for the required hoisting speed and capacity, when driven by high-speed engines. Straight drums should be used, as there is no advantage to be gained by special designs of cone-drums, rope-reels or other hoisting systems, sometimes advocated, over straight-drum designs, with the drums made as small as they may be made by using engines of high rotative speed to drive them."

SHOP TESTING OF MATERIALS.

THE DETERMINATION OF THE QUALITY OF A METAL BY ITS RESISTANCE TO THE OPERATION OF PUNCHING.

L. Baclé—Société d'Encouragement pour l'Industrie Nationale.

IN determining the quality of a metal for purposes of construction it is usually considered desirable to subject certain test pieces to determinate stresses in suitable machines, constructed expressly for the purpose, and this plan should be adopted, and the results recorded, in all important work. At the same time it is possible to learn much about the character and quality of a material simply by observing its behaviour under the various machining operations to which it is subjected in the course of manufacture, and this plan possesses some advantages. Thus it is not always certain that the piece selected for the examination in the testing machine fairly represents the actual portion which is to be included in the completed structure, besides which it is necessary that all the conditions under which the testing is done should be known in order to enable the results to be used with confidence. If, however, the resistance offered by the actual piece under consideration can be measured, without requiring any special testing, the engineer is placed in possession of a method of great utility and extended application.

In a paper recently presented before the *Société d'Encouragement pour l'Industrie Nationale* by M. Baclé, himself well known as an expert in the department of engineering work including the testing of materials, the use of the process of punching is considered in connection with the determination of the quality of the metal under manipulation, and some abstract of his discussion will be found of interest and value.

As long ago as 1836 the first direct-acting steam punching machine was made by Cavé and Lemaître, and they soon noticed the marked difference in resistance to punching offered by forged pieces compared with those of puddled metal, and from these observations the use of punching as a method of testing may be dated. The machine used by these experimenters included two fly-wheels fixed directly upon the engine crank shaft, and these, having but a low velocity stored up but a moderate amount of energy. As a result of this arrangement there was an appreciable reduction in velocity due to the resistance of the metal to the punch, and it was altogether possible to perceive, by the extent of the reduction in velocity, the relative resistances of various materials. Of course, such a method gave only the most general indications, but it has shown the applicability of the operation to more refined and precise determinations.

About ten years ago M. Frémont devised a so-called elasticimeter, a device indicating the effort involved in punching by measuring the elastic flexure of the machine in which the work was done. In this method the yield of the frame of the punching press was caused to operate a recording device which enabled the punching force to be determined by inspection, thus converting the operation into a quantitative one. M. Baclé has further improved upon this for his own purpose of research by constructing a special punching machine, made intentionally with a deep throat and constructed of steel, thus giving a larger degree of elastic yield than would ordinarily be the case. By operating the machine by hand it has been found possible to stop the operation of punching at any point, and in this way the resistance of the material at different depths of penetration have been determined. A comparison of the results thus obtained with those found by tension and shearing tests on the same material has enabled the relation of the punching resistance to the tensile and shearing strength to be found, and these comparative relations have been reduced to formulas and plotted as diagrams by M. Baclé.

It appears that the maximum resistance to the operation of punching bears a direct relation to the tensile strength of the metal, so that the latter may be determined by the observation of the former, and if, as is usually the case, a number of holes are to be punched in the metal, a far more general average will be obtained than could be possible from a few tension tests. It is not to be expected that the method will give results of such a high degree of precision as are possible with the refined apparatus of the testing laboratory, but a thoroughly practical knowledge of the operative resistance of the material may be obtained, without interfering at all with the progress of the work through the shop. M. Baclé has plotted results upon materials ranging in tensile strength from 30 to 75 kilogrammes per square millimetre (42,670 to 106,675 pounds per square inch) and shows that within these limits the method presents results well within the degree of precision demanded in practical work.

So far as the question of elongation is concerned, M. Baclé admits that the punching method permits results of but partial value to be obtained. The ductility of the metal is fairly well shown by the behaviour during punching, but it must be remembered that the total elongation shown in tension tests includes two distinct elements which it is not always easy to separate. One of these elements is the elongation corresponding to the reduction in sectional area, or, as M. Baclé calls it, the elongation of striction, while the other is the elongation due to the actual yielding of the material, distributed over the whole area. These two are almost invariably added together and considered as to total elongation. Since the real reduction in area is not easy to measure, especially in pieces of irregular section, it is common to consider only the total elongation, and the conclusions drawn from such data may be very misleading, even in the case of tension tests otherwise accurate and reliable. In the case of punching tests, however, it is possible to draw very useful conclusions as to the ductility of the material from the form of the diagram.

It is evident that the use of punching as a method of testing has many advantages, and intelligently used it enables the quality of the material under manipulation to be controlled within practical limits. It is not intended to be used as a substitute for the more precise methods of the testing laboratory, but rather as an auxiliary, and when so used it may be made a valuable aid to the production of reliable work.

The use of the elasticity of the frame of a machine tool or testing machine as a means of securing a record of stresses is not new, but it is an entirely practical method which is undoubtedly capable of further useful application.

THE UTILISATION OF TIDAL POWER.

PRACTICAL METHODS OF OBTAINING MOTIVE POWER FROM THE RISE AND FALL OF THE TIDES.

The Engineer.

THE question of utilisation of tidal power is a problem which has attracted attention at various times, and numerous plans have been devised for its solution. Some of these have been entirely practical, such as the small tide mills occasionally found on streams within the tidal reach along the coast, but these are little more than toys. Many great schemes have been planned by amateurs, but have never passed the paper stage, and as a matter of fact little or nothing has really been done in a practical way on a scale of any magnitude.

The general subject of tidal power schemes is discussed in recent issues of the *Engineer,* and the practical nature of the treatment renders it well adapted for a presentation of correct ideas on a matter concerning which some extravagant views are often held.

"To a casual observer it might appear that a great deal of power is daily exerted by the tidal forces in raising ships and other objects floating on the surface of the sea from low-water to high-water level. The work done is, however, relatively small, as recourse to figures readily proves.

"Let us take, as an example, H. M. S. Kent, afloat at a place where the range of tide is 15 ft. By referring to the Navy List we find the displacement of this ship to be 9,800 tons. Assuming the rise of the tide to take place in six hours, the average horse-power exerted upon the ship is—

$$\frac{9{,}800 \times 2{,}240 \times 15}{33{,}000 \times 6 \times 60} = 27\tfrac{3}{4} \text{ nearly,}$$

quite an insignificant amount when we observe that the indicated horse-power of the engines is given as 22,000.

Apart from any questions of cost, one of the difficulties connected with the operation of entrapped water in high-tide basins, is found in the irregular character of the power development. This is partially obviated in the system of M. Decoeur, proposed for application in France. Instead of using a single high-tide basin, this plan employs two basins, the water level in one, the high-water basin, ranging from high water to, say, one-third of the tidal range below high water, and the water level in the other, the low-water basin, from one-third of the tidal range above low water to low water. The flow through the turbines takes place from the high-water basin to the low-water basin, the two basins receiving and discharging from and to the sea. The two basins are fitted with automatic gates, the flow from the sea into the high-water basin taking place as soon as the tide outside rises above the water level inside, while the converse occurs in the low-water basin, the gates opening outwards as soon as the outside water level falls below the inside. Elaborate plans were made for the development of this system on the banks of the Seine at Havre, but these were never executed, probably because of the possible injury to the port of Havre by the works.

Apart from any difficulties connected with the irregularity of the motive power, the cost of installation plays an important part in any system of tidal power generation including the use of entrapping reservoirs. Such works are necessarily to be located at points where there is a reasonable demand for power, and where, in consequence, the value of the land and water rights are high. If the plan can be made to include natural basins, such as are found in some tidal estuaries, this cost may be kept within reasonable limits, and it may then be possible to secure power and a moderate charge including a reasonable allowance for interest and depreciation.

"In considering the economy of a tidal power scheme, the extremely high efficiency of all water motors as compared with other classes of engines must not be overlooked. Steam engines rarely give more than 12 per cent., and gas engines 20 per cent., of the energy due to the combustion of the fuel. Some of the best turbines give 80 per cent. or more of the theoretical power, at full gate.

"Not only is a due consideration of the

natural adaptability of the coast line to the construction, at a moderate cost, of enclosing dams necessary to the inauguration of a successful tidal power scheme, but the range of tide at the place selected is an element of the highest importance.

"The variation of range from springs to neaps is a difficulty which requires considerable ingenuity to meet satisfactorily, but the diurnal inequality which amounts, for example, at Bombay, to 6 ft., is practically non-existent in the United Kingdom. The tidal range in estuaries is greater than that on the open coast.

"Turning now to an entirely different aspect of the question, we find that the lot of a worker in our tidal factory would not be a very happy one at least until he had become accustomed to the novel conditions of labour to which he would be subjected. The working hourse would be regulated by lunar not by solar time. Assuming that the turbine installation gives eighteen solar hours' work per solar day of twenty-four hours, it would be necessary to have two shifts each working nine hours. If the establishment of the port were four hours at full and change of moon, one gang would begin work about seven solar hours after the moon had crossed the meridian either in the zenith or nadir; that is, about one hour after moonset or one hour after moonrise. Therefore, at spring tides one gang would work the greater part of the day and the other the greater part of the night. The second gang would have the benefit of brilliant moonshine when the moon would be in opposition, or no moon when in conjunction. If these conditions of work were stable there would be little to complain of. The night workers might receive additional pay to compensate them for the disadvantage of night work. But, owing to the lunar day being fifty minutes longer than the solar, the working hours would be continually changing with respect to the sun.

"In the way of good works management much might be done to reduce to a minimum the loss consequent on fluctuations of power. The heavier classes of work might be done at spring tides; and at neaps machines for the finer processes might be brought into play. Much of the surplus power might be used for the electro-deposition of silver and other metals. Indeed, few industries lend themselves more naturally to this form of motive power than electro-plating. The quantity of metal deposited is directly proportional to the quantity of current used. Current for this purpose might be granted at a lower rate at springs. At neaps all hands might be employed in polishing and preparatory processes. The grinding of corn and of the materials in the manufacture of cement, the crushing of ores, the electrolysis of water and of chemical salts, the crushing and hackling of jute and flax—all these, and doubtless many of the heavier operations in other industries, might be economically carried on at the lowest rates possible at springs. But if in practice such arrangements were found impracticable or costly, then by the extension of the high-level reservoir system the supply of power might be made absolutely constant."

WATER-POWER FOR ELECTRIC TRACTION.

THE UTILIZATION OF THE HYDRAULIC POWER OF THE PACIFIC COAST FOR THE ELECTRICAL OPERATION OF RAILROADS.

Robert McF. Doble—Pacific Coast Railway Club.

WE have referred elsewhere in this issue to the problems connected with the introduction of electric traction on main-line railroads, but in the great majority of cases it must be assumed that the original source of power will be a steam driven central generating station, and it is on this assumption that the computations are generally made in comparing electric traction with steam locomotives. In a paper presented before the Pacific Coast Railway Club Mr. Robert McF Doble calls attention to the adaptability of water power in certain localities.

The advantages of electric over steam traction may be considered under three heads: those appealing to the passenger, and resulting in an increase in traffic; those pertaining to the centralization of power; and those relating to economies in first cost, and maintenance and operating expenses. Under the first head may be included the freedom from dirt and smoke, and the general cleanliness and the better ventilation and lighting of the cars. These, however, are possessed by electric traction regardless of the source of motive power, and hence have no especial applicability to the question of hydraulic power. The matter of power centralization, however, is a different matter. The steam station has many limitations, and it is a matter of interest to note that these limitations are most marked in localities where hydraulic power is most available. Thus the development of electric traction in Switzerland and in Northern Italy has been most apparent in connection with the fact that both of these countries, while possessing no coal, have ample sources of water power capable of development in the Alps and available for transmission to the adjacent valleys and plains.

The same is true on the Pacific coast, where available water powers are distributed at frequent intervals all the way from Southern California up to British Columbia. But a small portion of this power has as yet been developed, but enough has already been done to show the possibilities of the country. The stations now in operation, and the success which had been had with long-distance transmission from the mountains to the coast, indicate that the operation of railroads by hydraulic power and electric transmission should be a profitable matter. It is entirely possible to arrange the location of hydro-electric stations so as to permit several power plants to feed into one distributing network, each supplementing the power of the other, and precluding the possibility of any general interruption. Since the capacity of the steam locomotive has to be that of the maximum effort required, even though that effort be for a very short time, there is a distinct advantage in the electrical system, in which the load on the power station is only the sum of the loads on the different motors, averaging much less than the sum of their maximum powers.

The application of electric traction in California affords especial opportunity for the development of those systems in which the recovering of the energy required for braking is included, this plan having already been developed in Europe, as on the new Jungfrau line, and elsewhere. The power developed by the trains on the descending mountain divisions, frequently occurring in California, may thus be utilized in connection with electric traction, while wholly lost when steam locomotives are employed.

Turning to the achievements of electric traction in California, Mr. Doble made particular reference to the Los Angeles and Rodondo Railway, the Pacific Electric Railway of Los Angeles, and the North Shore and Key Route systems of San Francisco. The North Shore Railroad is of special interest by reason of its being the first and only third-rail line in California and because of its being operated from a sub-station which is the terminus of one of the longest transmission lines in the country. The Alto station referred to is 180 miles from the hydro-electric plant at Colgate and 250 miles from the new De Sabla power house. One of the features of the Key Route system is the diamond trolley, which is successfully used on all of its trains.

As to projected electric lines on the Pacific Coast, Mr. Doble referred to improvements which the Southern Pacific Company has under consideration for its suburban lines in Oakland, Berkeley and Alameda, to the rumored electrification of that company's San Jose and Port Costa lines and also to the possibility of operating its mountainous divisions by electricity. Mr. Doble concluded with some very interesting remarks on the leading hydro-electric power stations and transmission systems of California. The distinguishing characteristics of each plant were mentioned and special reference was made to the new De Sabla power house of the California Gas & Electric Corporation, where is now operating an 8,000 horse power tangential water wheel, said to be the largest single water wheel ever constructed. This station regularly supplies power to San Francisco and other points over 300 miles distant.

It is believed that this plant includes the longest electric-power transmission which has yet been operated, although it is probable that the limit has by no means been attained.

REFUSE DESTRUCTOR STATIONS.

THE COMBINATION OF DUST DESTRUCTORS AND ELECTRICITY WORKS ECONOMICALLY CONSIDERED.

W. P. Adams—Institution of Electrical Engineers.

IT is now generally conceded that the best way to dispose of organic refuse is by fire, but notwithstanding the improvements which have been made, and the continual efforts directed toward the complete solution of the problem there yet remains much to be done before entire satisfaction can be said to have been attained. In a paper presented before the Institution of Electrical Engineers by Mr. W. P. Adams some of the latest work which has been done in this direction is described, and the paper together with the discussion which it elicited demands attention and review.

A large portion of Mr. Adams's paper relates to descriptions of the construction and performance of well-known types of destructors in various localities, and for these the reader must be referred to the original paper. He also gives some general principles, however, which may well be repeated here as forming an excellent guide to designers of such plants.

"The points in common with all modern high-temperature destructors are, forced draught, preferably heated, means of drying the refuse in part before placing on the grate, and a combustion chamber in which all gases are mixed and brought to a state of high incandescence and their temperature equalized so far as possible.

"Steam blast for producing forced draught is claimed to have advantages over simple air blast in that it produces water gas in passing through the incandescent fuel, which materially aids combustion; it also tends to keep the fire bars cool, thus giving them an appreciably longer life and clinkering is rendered easier. It is an extremely difficult matter to measure the steam blast, except on specially arranged tests, but it is a very simple matter to measure the power used by electrically driven fans. However, it is a question that does not turn entirely on the relative consumption of power, as the improved combustion with fuel of high calorific value may outweigh the extra percentage of steam used with steam blast. This is one of the interesting points upon which additional information would be of value, but it will be a hard matter to justify the application in the blast of twenty to forty per cent. of the total steam generated. Economy in the blast is of considerable importance, as the absorption of power is continuous, and if a wasteful form be used a large percentage of its power available is wholly lost.

"The prevention of air leakage is another important matter, and long and badly arranged flues are also a prolific source of lost power. A principle never to be lost sight of in the construction of destructors is, that after the perfect cremation of the refuse has been secured, the heated gases should be applied directly to the boiler without having to pass through long flues. Again, the charging arrangements are sometimes crude and not designed or constructed with a full appreciation of the problem involved; the furnaces of the boilers are often a source of trouble through air leakage and unsatisfactory combustion effects, and not a few combined works show poor results through careless and indifferent handling of the refuse and management of the burning.

"The composition of refuse varies largely in different parts of the country; in the neighborhood of coal mines it is often rich in carbon. In towns having a staple industry, where much waste material from the factories is sent to the destructor, the calorific value of the refuse may be high or low, according to the carbon in such waste material. Suburban residents generally provide quantities of garden stuff to feed the destructor, and although the percentage of carbon in this stuff is large, so also is the percentage of moisture, and it is therefore not regarded with favor by destructor managers."

It is a matter of interest to note that the richest refuse often comes from the poorest localities, while from the wealthies districts near by the material is of only an average quality. This is attributed to the greater wastefulness of the working classes, and however this may be, the fact appears to be well substantiated.

"Some of the difficulties to be met with in the utilization of refuse-raised steam for electrical purposes are—uncertain delivery of the refuse, the varying value of the refuse from day to day and hour to hour, and the varying percentage of moisture contained; also in winter snow may prevent collection for many days, fog sometimes greatly hampers collection, and holidays occasionally prevent collection for days. By careful management and forethought some of these difficulties may be largely neutralized, but it is merely sufficient to call attention to them to demonstrate that only under favorable conditions may a combined plant be expected to run for any length of time on refuse alone.

"To equalize to some extent the varying quantities collected, and also to adapt the quantity burnt to the varying demand for electricity, some system of storage is desirable; this is especially so where the electricity works has a small day load. The refuse itself may be stored and burnt as the demand requires, or, when direct-current plant is used, a battery may be employed with advantage. A large destructor plant is best run seadily throughout the twenty-four hours, and no great difference in the rate of burning during the day and on the peak is admissible. With a twelve-cell plant, eight cells might be run during the day and twelve at night. This represents a maximum variation, and it will, therefore, be seen that where the day load is small, a peak load some five times greater could not be coped with in this manner. These batteries are to be strongly advocated for they not only serve for storage during the day, but with a suitably arranged reversible booster they equalize the load when the steam generation varies, as it does very rapidly sometimes. To secure the best results such a battery need not be abnormally large. A combined station burning some 30,000 tons per annum would require a battery of about 1,000 to 1,500-kilowatt-hour capacity, assuming a simple lighting load with a day demand about one-fifth of the peak load."

In view of the fact that a destructor station is primarily intended for the destruction of refuse, and only secondarily as an electrical generating plant several points must be considered.

At first it is probable that ample heat will be furnished for the demand for electricity supply for the district. The demand for current, however, is apt to increase faster than the supply of refuse, so that provision must be made, either for increase with coal fired boilers, or by the erection of an auxiliary generating station.

Again, the destructor station must be located where it will be as unobjectionable as possible, and this may render it inconvenient as an electricity supply source. These points may well be met if considered in the beginning, but may otherwise become troublesome later. In every event, however, it must be remembered that the complete and inoffensive combustion of the refuse is the main end to be accomplished, and that the power generated should be considered only after this has been successfully accomplished.

STRESSES ON HYDRAULIC MAINS.

A STUDY OF THE CAUSES OF DEFORMATION OF LARGE HYDRAULIC CONDUITS FOR POWER PLANTS.

C. Birault—Société des Ingénieurs Civils de France.

THE ordinary practice in the computation of the strength of mains for conveying water has been to use dimensions sufficient to resist the internal pressure, and in most instances this gives ample strength for all purposes. With the development of hydraulic power plants, in which large sheet-metal pipes are used to convey water from distant and elevated sources to the lower level of the power station, it has become common to lay the mains directly upon the surface of the ground, and under such conditions the deforming stresses, due to the weight of the pipe itself as well as the contained water, should be taken into account. A paper presented before the Société des Ingénieurs Civils de France by M. C. Birault, and published in the *Mémoires* of the society, examines the causes acting to produce flexure of the walls of such conduits, and some brief abstract of his discussion is of interest.

M. Birault considers especially the practice in France, where the development of the "white coal" in the Alps has already resulted in the utilization of about 150,000 horse power, and where new projects are continually being considered. The sheet metal mains, of moderate thickness and large diameter, used for the conveyance of the melting snow to the power houses in the valleys, are here found to need special attention to enable them to resist the forces tending to cause them to flatten, or become oval, even under their own weight, apart from the load of the contained water. This is especially the case when conduits as large as 2.50 to 3 metres in diameter are employed, these sometimes being made of mild steel, with walls as light as 6 to 7 millimetres at the origin, where the internal pressure is light.

An example of the experience gained in France is found in the main constructed in the Isère district for the Clavaux Works, in which a main 2.5 metres in diameter, for a head of 42 metres, and a total length of 1,000 metres, was made 6.5 mm. thick at the origin, and 13.5 mm. thick at the lower portion. This conduit was to be supported on masonry piers, but it was found, on erection, that the piers penetrated into the main, so that it was necessary to reinforce the latter with ribs of channel bars to secure sufficient rigidity, although the thickness was ample to resist the internal pressure.

The best method of supporting such mains is undoubtedly the employment of a semi-circular cradle or foundation in the ground for the entire length, but this arrangement is not always possible. In other cases masonry supports, with cradles of structural metal, may be used, and if these are sufficiently close together no further reinforcement is necessary, otherwise longitudinal ribs of angle of channel iron should also be added.

For the higher portions of such mains the construction may be of reinforced concrete, the thickness of the concrete giving ample stiffness to resist circumferential deformation, although this method should be supplemented by longitudinal supports when the conduits are carried on widely spaced piers. The thickness of the lower levels of a high pressure main, necessary to resist the internal pressure, generally gives enough stiffness to prevent deformation, and the principal care is required in connection with the upper portion, where a thin pipe is sufficient if properly braced against deflection.

M. Birault gives a mathematical treatment of the stresses upon such conduits under various conditions, plotting curves showing the changing stresses during the filling of the main with water, as well as the influence of different supports.

Whenever possible, mains of large diameter should be given continuous support, or if piers are necessary they should be placed sufficiently close together to render the longitudinal stresses and consequent flexure negligible. If the local conditions compel the use of widely spaced piers, there should be a double system of longitudinal and transverse bracing, computed according to the formulas deduced for the span and the diameter of the main.

Pipes of moderate diameter are generally thick enough to resist flexure, even when supported on isolated piers, and the stresses in such cases may be computed in the same manner as for ordinary beams.

M. Birault calls especial attention to the desirability of placing the longitudinal riveted seams so that they will not be subjected to longitudinal deflection, this being entirely possible if the moments of flexure are studied according to the conditions of support of the respective portions of the main.

The principal point to be emphasised is the necessity, in the design and erection of mains of large diameter, of taking all the stresses into account, and, instead of merely making a pipe of the required diameter, sufficiently thick to resist the internal pressure, such a main should be designed, under competent engineering supervision, for the especial location for which it is intended, with full knowledge of the manner in which it is to be supported, and it should be erected in the precise manner in which it was intended by the engineer by whom it was designed.

THE ENGINEERING INDEX

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(5) Where published,
(6) When published.

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The full text of any article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering 1003
Electrical Engineering 1011
Industrial Economy 1016
Marine and Naval Engineering.... 1017
Mechanical Engineering 1018
Mining and Metallurgy............ 1026
Railway Engineering 1032
Street and Electric Railways..... 1035

CIVIL ENGINEERING

BRIDGES.

Arches.

A Statical Examination of Flat Arches (Zur Statischen Untersuchung von Flachen Gewölben). Dr. Josef Schreier. A mathematical treatment developing formulas for use in designing masonry arches of small size in proportion to span. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 6, 1905. No. 67335 D.

The Stone Bridge at Hartford, Conn. Illustrating and describing a masonry highway bridge of eight semi-elliptical arches with spans of 68 to 119 feet, now under construction. 4000 w. Eng Rec—Dec. 31, 1904. No. 66959.

Drawbridges.

An Electrically Operated Highway Drawbridge for Small Waterways. H. G. Tyrrell. Plan and description of a design prepared for a bridge to cross the Miami and Erie Canal at New Bremen, Ohio. 900 w. Elec Rev, N. Y.—Dec. 31, 1904. No. 66983.

The New Newark Bay Bridge. S. D. V. Burr. Illustrates and describes the tandem Scherzer rolling lift bridges on the Central Railroad of New Jersey. 800 w. Ir Age—Jan. 5, 1905. No. 67007.

Erection.

A Difficult Piece of Bridge Erection in Connection with Terminal Improvements of the New York Central & Hudson River R. R. Co. Frank C. Shepherd. An illustrated description of the peculiar conditions and the methods employed. 1200 w. Eng News—Jan. 5, 1905. No. 67044.

Failure.

The Charleston Bridge Failure. H. G. Tyrrell. An illustrated account of the failure of a suspension bridge at Charleston, W. Va., and an explanation of the cause. 900 w. Eng News—Jan. 5, 1905. No. 67047.

The Charleston Bridge Failure. Illustrations of the present condition of the wrecked bridge, with information concerning the cause, and editorial comment. 2000 w. Eng Rec—Dec. 31, 1904. No. 66963.

Hinges.

Experiments with Sandstone Blocks for the Hinge Joints of Arches (Versuche mit Sandsteinquadern zu Brückengelenken). C. Bach. Experimental researches upon the crushing of sandstone rocker-hinge blocks as used in masonry arches, with diagrams for arches of various radii. 1200 w. Zeitschr d Ver Deutscher Ing—Dec. 17, 1904. No. 67301 D.

Plate-Girder.

A 100-Foot Plate-Girder Span with Unusual Bearings. Illustrated description of the new 100-ft. span at Ship Pond Stream, Me. 1500 w. Eng Rec—Jan. 14, 1905. No. 67178.

The Bethlehem Junction Bridge. Illustration, with description, of a single-track plate-girder bridge with a clear span of 80 feet, carrying the C. R. R. of N. J. over the Lehigh Canal, recently built to replace an old skew-bridge. 2000 w. Eng Rec—Jan. 21, 1905. No. 67404.

Reconstruction.

Rebuilding the Big Four Bridge at Terre Haute. Illustrates and describes changes being made in a bridge over the Wabash River. Three Pratt truss spans, too light for present loading, are being replaced with two 184-ft. spans. 700 w. R R Gaz—Vol. XXXVIII, No. 4. No. 67491.

The Reconstruction of the Point Bridge, Pittsburg, Pa. Willis Whited. An illustrated article describing the condition of the old structure, the repairs that were made, and the manner of executing the work. 4800 w. Eng News—Jan. 26, 1905. No. 67479.

Reinforced Concrete.

Reinforced-Concrete Girder Bridge at Bamberg (Balkenbrücke in Eisenbeton in Bamberg). Description of the construction and erection of highway girder bridge of 21 metres span. 1200 w. Deutsche Bauzeitung—Jan. 11, 1905. No. 67398 B.

See also Civil Engineering, Construction.

Skew-Arch.

A Skew-Arch of Concrete Steel. Drawings and description of details of a bridge over St. Joseph River, in South Bend, Ind. 800 w. Munic Engng—Jan., 1905. No. 67219 C.

Substructure.

The Substructure of the Cambridge Bridge, Boston. Describes the substructure of a bridge over the Charles River, which is to carry an important city street, and has been designed with a view to harmony with the surroundings. 3400 w. Eng Rec—Jan. 14, 1905. No. 67179.

Transfer-Bridge.

The Nantes Transfer-Bridge. Illustrates and describes a bridge recently built over the Loire differing in many ways from the usual designs. 1200 w. Engng —Jan. 13, 1905. No. 67450 A.

Viaduct.

A Boulevard Supported on Cantilevers. Brief illustrated description of a cantilever platform to be erected to carry Riverside Drive over the railroad tracks in New York City. 800 w. Eng Rec—Jan 28, 1905. No. 67520.

Wind Pressure.

Probable Wind Pressure Involved in the Wreck by the High Bridge Over the Mississippi River on Smith Avenue, St. Paul, Minn., Aug. 20, 1904. Discussion of the paper by C. A. P. Turner. 1800 w. Pro Am Soc of Civ Engrs—Dec., 1904. No. 66970 E.

CONSTRUCTION.

Balcony.

The Computations for a Half-Ring Balcony (Berechnung Halbringforiger Balkontrager). Dr. Leopold Pfeffer. A graphical and analytical examination of the stresses in a projecting balcony of semi-circular or semi-elliptical form. 5000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 26, 1904. No. 67379 D.

Boulders.

Methods and Cost of Blasting and Handling Boulders. Daniel J. Hauer. Explains the different methods of handling and breaking up both large and small boulders, giving some data as to the cost. 6500 w. Eng News—Jan. 5, 1905. No. 67045.

Building Construction.

Structural Features in the Phipps Power Building, Pittsburg, Pa. Edward Godfrey. Brief illustrated description of the structural steel works. 1300 w. Pro Engrs Soc of W Penn—Nov., 1904. No. 67241 D.

The Structural Design of Buildings. Continued discussion of paper by C. C. Schneider. 6000 w. Pro Am Soc of Civ Engrs—Dec., 1904. No. 66971 E.

The Structural Design of Buildings. Continued discussion of paper on this subjeet by C. C. Schneider. 7000 w. Pro Am Soc of Civ Engrs—Jan., 1905. No. 67503 E.

Dams.

Essential Elements in the Design of Dams. John S. Fielding. Considers matters pertaining to these structures, their stability, economy, etc. 2200 w. Can Engr Jan., 1905. Serial. 1st part. No. 67149.

Rolling Dams at Schweinfurt, Bavaria. Emile Guarini. Illustrated description of interesting movable dams and their working. 7000 w. Eng News—Jan. 19, 1905. No. 67284.

The Charles River Dam and Basin at Boston and Cambridge, Mass. J. Albert Holmes. Treats principally of the foundations of the lock and sluices and the proposed shut-off dam. Ills. 2500 w. Eng News—Jan. 12, 1905. No. 67154.

The Roosevelt Masonry Dam, on Salt River, Arizona. Description of a high masonry dam, which is to form a reservoir of 320,000,000,000 gallons capacity. Ills. 2500 w. Eng News—Jan. 12, 1905. No. 67156.

Docks.

See Civil Engineering, Waterways and Harbors.

Ferry-House.

The New Steel Ferry-House of the Central R. R. of New Jersey. Illustrates and describes the new ferry-house at the west end of 22d st. in New York. 3000 w. Eng Rec—Jan. 7, 1905. No. 67070.

Frameworks.

A Graphical Examination of the Stresses in Framework Struts (Graphische Ermittlung der Einflusslinien für die Stabspannungen in Ständerfachwerk). S. K. Drach. A special graphical method for members subjected to thrust. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 30, 1904. No. 67334 D.

A Steel-Frame Riding Academy Building. Brief illustrated description of a building recently erected at Scituate, Mass. 800 w. Eng Rec—Dec. 31, 1904. No. 66964.

The Influence of Horizontal Forces upon Framed Structures (Einflusslinien für die Beanspruchung Gerader Fachwerkträger durch Horizontale Kräfte). Wenzel St. Ritter v. Balicki. A graphical investigation of the action of horizontal forces upon various forms of roof and bridge trusses. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 16, 1904. No. 67331 D.

The Steel Framework of the Trinity Building, New York. An illustrated detailed description of a building of twenty-one stories, or nearly 300 feet above the curb. 2700 w. Eng Rec—Jan. 14, 1905. No. 67177.

Grain Pressure.

The Problem of Grain Pressure. Wilfrid Airy. Discusses the principal points in papers of Isaac Roberts and H. A. Janssen, and gives a general explanation of the problem. 3500 w. Engng—Jan. 6, 1905. No. 67202 A.

Reinforced Concrete.

A Five Years' Test of an Experimental Reinforced Concrete Arch of Sixty-Six-Foot Span. From a lecture by Herr Hoch, describing the construction of an experimental concrete arch reinforced by iron and the results of observations for a period of five years, when it failed. Ills. 2200 w. Cement—Jan., 1905. No. 67221 C.

Design and Construction of a Reinforced Concrete Wharf at Ymuiden, Holland. Illustrated description of a structure built by the government for the fishery harbor located there. 1800 w. Cement—Jan., 1905. No. 67223 C.

Notes on European Reinforced Concrete Structures. Remarks on papers recently read at a meeting of the Royal Inst. of British Archts. on Hennebique reinforced concrete structures. 1700 w. Eng Rec—Jan. 14, 1905. No. 67175.

Reinforced Concrete Construction Theoretically Considered. Sidney B. Williamson. Some of the general principles on which this material is based, with theoretical analysis by Prof. W. K. Hatt, as the result of tests made, and information from other authorities. Ills. 2000 w. Cement—Jan., 1905. No. 67222 C.

Report of Fire, Load and Water Test Made at the Fire-Testing Station, Columbia University, N. Y., upon a Kahn System, 15-Foot Span, Reinforced Concrete Floor, Constructed by the Trussed Concrete Steel Company. Ira H. Woolson. Ills. 1300 w. Cement—Jan., 1905. No. 67224 C.

Tests of Reinforced Concrete Beams. From the report of the Boston Transit Commission. An illustrated report of tests, giving size of beams and methods of reinforcing them. 1100 w. R R Gaz—Vol. XXXVIII, No. 3. No. 67282.

The Chapel of the U. S. Naval Academy, Annapolis. Illustrates and describes an interesting building under construction, in which reinforced concrete is extensively used. 800 w. Eng Rec—Jan. 14, 1905. No. 67174.

The Computation of Reinforced Concrete Beams and Plates (Beitrag zur Berechnung Armierte Betonbalken und Platten). J. Melan. Deriving formulas for beams and ribbed plates, together with a diagram of curves for practical use. 2000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 17, 1904. No. 67381 D.

The Concrete-Steel Headworks of the Ontario Power Company, Niagara Falls. Describes the reinforced concrete work. Ills. 2500 w. Eng Rec—Jan. 14, 1905. No. 67181.

The Development of Reinforced Concrete in Europe. E. Probst. An illustrated article reviewing the development and describing types of construction. General discussion. 5000 w. Jour W Soc of Engrs—Dec., 1904. No. 67257 D.

The Greek Amphitheater at the University of California. C. W. Whitney. An illustrated description of the advantageous use of concrete for this work. 2800 w. Eng Rec—Dec. 31, 1904. No. 66958.

Typical Structures in Concrete-Steel. Describes and illustrates details of some typical buildings and other structures in concrete-steel. 2500 w. Builder—Jan. 7, 1905. Serial. 1st part. No. 67189 A.

See Also Civil Engineering, Bridges.

See Civil Engineering, Municipal.

Road Maintenance.

The Maintenance of New York State Roads. Suggestions from bulletin issued by Mr. Henry A. Van Alstyne, State Engineer, dealing with gravel, macadam, and stone roads. 2000 w. Eng Rec—Jan. 21, 1905. No. 67409.

Roofs.

Formulas for Hips and Valleys. O. E. Emrich. Formulas and diagrams, with brief explanation. 600 w. Eng Rec—Jan. 7, 1905. No. 67072.

Structural Engineering.

The Relation of the Engineer to the Architect. Corydon T. Purdy. Read at the convention of the Am. Inst. of Archts. Considers the various methods of accomplishing work requiring both architects and engineers, and offers suggestions for adjusting their relations. 7500 w. Eng News—Jan. 26, 1905. No. 67481.

Tunnels.

An Improved Method of Constructing Tunnel Linings (Die Richtige Tunnel-Kernbau-Methode). Michael v. Könyves-Toth. Describing an improved method of constructing a continuous concrete lining during the boring of a tunnel. 2000 w. 1 plate. Zeitschr d Oesterr Ing u Arch Ver —Dec. 30, 1904. No. 67333 D.

Tubular Tunnels in Wet Ground (Les Tunnels Tubulaires en Terrains Aquifères). C. Brault. A mathematical investigation of the stresses in submerged metallic-tube tunnels. 2000 w. Génie Civil—Dec. 24, 1904. No. 67311 D.

The Crossing of the English Channel. F. Arnodin. An explanation of the reasons why the author hesitates to recommend the construction of a tunnel beneath the English channel. 5400 w. Public Works—Jan., 1905. No. 67467 F.

Waterproofing.

Waterproofing Concrete Structures. W. H. Finley. Read before the Cement Users' Assn. On the necessity of waterproofing concrete, the importance of drainage, and the methods used by the writer. 2000 w. Eng Rec—Jan. 21, 1905. No. 67403.

Wind Pressure.

See Civil Engineering, Bridges.

MATERIALS OF CONSTRUCTION.

Bricks.

Sand Lime Bricks. H. Gerlings. Describes the methods of cementing the sand and lime, and other matters of interest in regard to their manufacture. 3000 w. Jour Chem, Met & Min Soc of S Africa—Nov., 1904. No. 67430 E.

Cement.

Materials Which Retard the Setting of Portland Cement. R. C. Carpenter. Gives a brief description of experiments made for the purpose of determining the regulating power on the cement of gypsum and chloride of calcium. 2200 w. Eng Rec—Dec. 31, 1904. No. 66961.

The Setting or Hydration of Portland Cement. Clifford Richardson. Read before the Assn. of Am. Portland Cement Mfrs. Gives results of investigations which are of scientific interest. 1200 w. Eng News—Jan. 26, 1905. No. 67478.

Cement Works.

The International Portland Cement Works at Hull, P. Q., Canada. John McClelland Bulkley. Illustrates and describes a factory comprising twenty buildings, that will have a capacity of about 2,000 bbls. per day. 2500 w. Eng Rec—Jan. 28, 1905. No. 67522.

Concrete.

The Compression and Shearing Resistance of Concrete (Schub und Scherfestigkeit des Betons). H. Morsch. Experimental investigations in connection with the proportions of members of reinforced concrete. Two articles, 4000 w. Schweiz Bauzeitung—Dec. 24, 31, 1904. No. 67338 each B.

Glass.

Glass Considered as a Material of Construction (Le Verre Considéré Comme Matériau de Construction). J. Malette. Discussing the applications of wire glass, glass tiles, prisms, and other constructive applications. Serial. Part I. 2000 w. Revue Technique—Dec. 25, 1904. No. 67320 D.

Lime.

Tensile Strength of High Calcium and Magnesium Lime. George V. Rhines. A comparison of the strengths of these two limes made by George S. Mills is given, with other information of value. 1200 w. Munic Engng—Jan., 1905. No. 67218 C.

Plaster.

The Manufacture of Plaster of Paris (Procédé de Fabrication du Plâtre). Louis Périn. With illustration of the Périn furnace, and description of the process of manufacture. 2500 w. Génie Civil—Dec. 31, 1904. No. 67313 D.

Reinforced Concrete.

See Civil Engineering, Construction.

Sand.

Mortar Sand. J. C. Hain. Read before the Nat. Assn. of Cement Users. Treats of the properties of various qualities of sand for use in concrete, giving an account of tests with interesting results. 4400 w. Ry & Engng Rev—Jan. 21, 1905. No. 67410.

Timber.

Australian Hardwoods (Ueber Autralische Harthölzer). C. Froitzheim. Describing Karri and Jarrah, two varieties of Eucalyptus used for piles, cross ties, wood pavements, etc. 5000 w. Glaser's Annalen—Jan. 1, 1905. No. 67327 D.

The Strength of Timber Treated with Preservatives. A statement of the results of tests carried out at the St. Louis Exposition by the Bureau of Forestry, U. S. Department of Agriculture. 1200 w. Eng News—Jan. 12, 1905. No. 67152.

The Tasmanian Blue Gum—An Ideal Timber for Harbor Building. Harold J. Shepstone. It is one of the strongest, most durable and denses timbers in the world, and is immune from attacks of the sea-worm. 2300 w. Ills. Sci Am—Jan. 21, 1905. No. 67290.

Wood Preserving. James McKeon. Describes the destruction of piles by marine insects, and considers briefly some of the methods of preservation tried, especially the creosoting process. 2500 w. Pro Pacific C Ry Club—Dec., 1904. No. 67461 C.

MEASUREMENT.

Field Work.

Engineering Field Work in the Colonies. W. G. Bligh. An illustrated article describing a type of angular instruments suited for rough work, and new types which will save time and labor. 3500 w. Public Works—Jan., 1905. No. 67464 F.

MUNICIPAL.

Conduits.

See Electrical Engineering, Distribution.

Destructor Plant.

See Electrical Engineering, Generating Stations.

Dresden.

The Public Works of Dresden. Dr. Karl Leutemann. An illustrated description of the city and its pubic works. 4500 w. Public Works—Jan., 1905. No. 67469 F.

Fire-Protection.

The Continental Fire Service. Edwin O. Sachs. Notes on Continental fire-brigade organizations, and the lessons to be learned. The present article is largely introductory. 2800 w. Engng—Jan. 13, 1905. Serial. 1st part. No. 67448 A.

Pavements.

Development of Bitulithic Pavement. Frederic J. Warren. Read before the Mass. Highway Assn., at Boston. An explanation of theories and results. Ills. 2800 w. Munic Jour & Engr—Jan., 1905. No. 66979 C.

Sewage Disposal.

A Recent Visit to Twenty-Four British Sewage Works. M. N. Baker. A report of visits to British sewage purification works, their methods of treatment, and matters of interest. General discussion. 9300 w. Jour Assn of Engng Socs—Dec., 1904. No. 67250 C.

Combined Chemical and Biological Sewage Disposal Works at Chichester, England. Description of these works which have been recently enlarged. 2000 w. Eng Rec—Jan. 14, 1905. No. 67180.

New Sewage Disposal Works in Middlesex. Reginald Brown. Illustrated detailed description. 2400 w. Public Works —Jan., 1905. No. 67470 F.

Practice in Sewage Disposal. Henry C. H. Shenton. Read before the British Soc. of Engrs. The latest methods employed, from the engineer's side of the question.

3000 w. Munic Jour & Engr—Jan., 1905. Serial. 1st part. No. 66978 C.

Sewage Disposal at Saratoga Springs, N. Y. Illustrated detailed description of recent improvements, embracing slow sand filtration beds in connection with septic tanks, a new main sewer, a small pump well and pumping station, an installation of electrically driven centrifugal pumps, etc. 4500 w. Eng Rec—Jan. 21, 1905. No. 67408.

The Bacterial Disposal of Sewage. G. Everett Hill. Discusses why sewage disposal is of vital interest, the methods in use, and the value of these methods. 6800 w. Jour Fr Inst—Jan., 1905. No. 67243 D.

The Functions of Various Types of Bacteria in the Purification of Sewage, with Some Methods for Their Quantitative Determination. H. W. Clark. A study in which attempts have been made to work out bacterial or bichemical tests which will give a bacterial measure of the changes which may occur in filters and filter effluents. 6500 w. Eng News—Jan. 12, 1905. No. 67153.

Sewerage.

A Recent Installation of a Liernur Sewerage System. Brief description of this system as recently applied in England. 1300 w. Eng Rec—Dec. 31, 1904. No. 66965.

Sewers.

A New Form of Reinforced Concrete Block Sewer Construction. An explanation of the construction and a statement of the advantages claimed. Ills. 1200 w. Eng News—Jan. 5, 1905. No. 67046.

The Harrisburg Sewer. S. M. Neff. Illustrated description of a concrete-steel intercepting sewer. 1600 w. Cement Age —Jan., 1905. No. 67490.

Sidewalks.

Sidewalk Construction for Small Cities. J. C. Herring. Notes on the methods of construction, materials used, grading, etc. 2500 w. Munic Engng—Jan., 1905. No. 67220 C.

Snow Removal.

Removal of Snow from City Streets. Leicester Allen. Discusses the cost of snow removal in New York City, and suggests the designing of a snow-melter that would lessen the expense. 2200 w. Eng Rec—Jan. 21, 1905. No. 67407.

Waste.

Municipal Waste. John H. Simon. Gives methods of disposal and reduction adopted after investigating systems of various cities. 2700 w. Munic Jour & Eng—Jan., 1905. No. 66980 C.

WATER SUPPLY.

Algae.

The Copper Sulphate Treatment for Algae at Middletown, N. Y. James M. Caird. A brief account of the treatment and results at the different reservoirs. 1200 w. Eng News—Jan. 12, 1905. No. 67155.

Corrosion.

Electrolytic Corrosion in Underground Pipes. Alec A. Beadle. An explanation of the change that takes place, and a suggestion for the prevention of corrosion. 1200 w. Elec Rev, N Y—Jan. 7, 1905. No. 67041.

Distribution.

The Arrangement of a Water Distribution System Fed by Two Separate Reservoirs (Ueber das Verhalten einer Wasserleitung die von Zwei Getrennten Hochreservoiren Gespeist Wird). Otto Seyller. Describing the water supply of Leoben, Austria, as extended by the inclusion of a second independent reservoir. 2500 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 7, 1905. No. 67385 D.

Filtration.

Small Sand Filter Plant for a Hospital at Poughkeepsie, N. Y. An illustrated description of a small plant, important owing to its novel features. 2000 w. Eng Rec —Jan. 7, 1905. No. 67068.

Ground Water.

Measurements of Underflow Streams in Southern California. Prof. C. S. Slichter. An illustrated article describing measurements made at the narrows of the Rio Hondo and the San Gabriel River, California, and at the narrows of the Mohave River, near Victorville; describing also the underflow water used. 5500 w. Jour W Soc of Engrs—Dec., 1904. No. 67259 D.

The Problem of the Movement of Water Through Permeable Ground (Problem sul Moto dell 'Acqua a Traverso Terreni Permeabili). Pietro Alibrandi. An elaborate mathematical treatment, deriving equations for the movement of ground water under various conditions. 12000 w. Ann d Soc d Ing e d Arch Ital—No. 3, 1904. No. 67390 F.

London.

London Water Supply: Old and New Methods. W. J. Fisher. An interesting review of the history of the water supply of London, and the recent uniting of the eight private companies into one. 3500 w. Westminster Rev—Jan., 1905. No. 67209 D.

Minneapolis.

The Water Supply of Minneapolis. J. Frank Corbett. Gives charts showing results of analysis of the water, and the number of cases of typhoid fever, with explanatory notes. 1300 w. Jour Assn of Engng Soc—Dec., 1904. No. 67249 C.

Pipe Scrapers.

Automatic Water Pipe Scrapers at Melbourne, Australia. Illustrates and describes an exceptionally compact automatic scraper. 2500 w. Eng News—Jan. 5, 1905. No. 67048.

Pumping.

Air-Lift Pumping Plant of the Redlands Water Co. An illustrated account of a test made in a plant in these irrigation works in California to determine its efficiency, with brief description of the plant. 1400 w. Eng Rec—Jan. 7, 1905. No. 67066.

Rainfall.

Maximum Rates of Rainfall at Boston. Charles W. Sherman. A record of rainfall from 1879 to 1904, inclusive, with discussion and comparison with records obtained elsewhere. 1500 w. Pro Am Soc of Civ Engrs—Dec., 1904. No. 66969 E.

Reservoirs.

Dams for Providing Water-Supply (L'Alimentation d'Eau par les Barrages). H. Peter. A description of several recent artificial reservoirs and illustrations of the dam across the valley of the Urve, near Aix-la-Chapelle. 2500 w. Bull Tech de la Suisse Rom—Dec. 25, 1904. No. 67378 D.

Water-Works.

The Water-Works of Porterville, California. Philip E. Harroun. An illustrated description of works for a town of about 2,000 inhabitants, with notes on the operation and cost. 8500 w. Pro Am Soc of Civ Engrs—Jan., 1905. No. 67501 E.

WATERWAYS AND HARBORS.

Bengal.

Inland Navigable Waterways of Bengal. Reviews the history of canal construction and river navigation, and its development. Ills. 2200 w. Engr, Lond—Dec. 30, 1904. No. 67143 A.

Canal.

Earthwork of the Seattle and Lake Washington Waterway Co. C. H. Rollins. Read before the Pacific Northwest Soc of Engrs. Describes the scheme and methods of construction of the canal connecting Puget Sound with Lake Washington. 4000 w. Eng News—Jan. 12, 1905. No. 67157.

Canal Conversion.

See Street and Electric Railways.

Canal Lifts.

A Design for a Canal Lift (Project d'Ascenseur pour Bateaux). Illustrating a design submitted for the Danube-Oder canal, employing a large revolving cylinder, carrying tanks for the boats. 1800 w. 1 plate. Génie Civil—Jan. 7, 1905. No. 67316 D.

Recent Canal Lifts (Neuere Schiffshebewerke). Hr. Krell. A discussion of the various propositions and designs for hydraulic lifts to replace locks in connection with the development of the internal waterways of Germany. 4000 w. Zeitschr d Ver Deutscher Ing—Dec. 24, 1904. No. 67302 D.

The International Competition for a Canal Lift (Der Internationale Wettbewerb für ein Kanal-Schiffshebewerk). B. Gerdau. Illustrating a design for an inclined plane entered in the Danube-Oder competition. 4500 w. 2 plates. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 24, 1904. No. 67383 D.

The Prize Designs in the International Competition for a Canal Lift (Die Preisgekrönten Projekte im Internationalen Wettbewerbe für ein Kanalschiffshebewerk). Karl Haberkall. The prize designs for the Danube-Oder Canal were for an inclined plane, and for a great revolving wheel. Two articles. 15,000 w. 7 plates. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 3, 10, 1904. No. 67380 each D.

Crane.

Floating Crane for the Harbor of Riga. (Schwimmkran für den Haben der Stadt Riga). L. Müller. Describing a powerful shear crane of 66 tons capacity arranged on a self-propelled float for harbor service. 2500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 7, 1905. No. 67303 D.

Docks.

The Modernization of Ancient Docks. Brysson Cunningham. States the changes which have necessitated the enlargement of docks, and discusses the problems in connection with the work. Ills. 4000 w. Engng—Dec. 30, 1904. No. 67135 A.

Drainage.

The Inlet Swamp Drainage District in Illinois. A. M. Shaw. Abstract of a paper read before the Illinois Soc. of Engrs. & Survs. Discusses the principal difficulties with which the district has to contend. 1600 w. Eng News—Jan. 26, 1905. No. 67480.

Dredger.

An Interesting Powerful Steam Dredger for Harbor Work. Illustration, with brief description of the "Vulcan," a powerful dredger in use at Liverpool. 700 w. Sci Am—Jan. 14, 1905. No. 67159.

Folkestone.

Folkestone Harbor Extension Works. Percy C. Tempest. Brief illustrated description of the work. 1000 w. Public Works—Jan., 1905. No. 67466 F.

Lighthouse.

The Repairing of the Lighthouse at Swinemünde (Instandsetzung des Leuchtturmes in Swinemünde). H. Kohlenberg. The weather-beaten brick tower was incased in a new outer wall of hard brick, bonded to the old structure. 1200 w. Zentralblatt d Bauverwaltung—Dec. 17, 1904. No. 67397 B.

N. Y. Harbor.

The New York Harbor Entrance. Lewis M. Haupt. A review of dredging operations intended to improve the channel, showing the inadequacy of this method under the conditions of littoral drift, and advocating the use of suitably located training walls to cause the opening and maintaining of the channel by natural forces. 1500 w. Sci Am—Jan. 7, 1905. No. 67027.

Nile.

The Control of the Nile. Sir Hanbury Brown. An illustrated article dealing with the means adopted to make Egypt produce more. The irrigation question. 11,000 w. Public Works—Jan., 1905. No. 67462 F.

Panama Canal.

Isthmus Canal: Sea Level Versus Locks. William W. Redfield. A brief discussion, explaining the writer's reasons for favoring the San Blas route for the canal. 1500 w. Jour Assn of Engng Socs—Dec., 1904. No. 67251 C.

Panama Canal. Editorial statement of the present discussion of routes, outlining the plans that have been considered. 1600 w. Engng—Jan. 13, 1905. No. 67453 A.

The First Annual Report of the Isthmian Canal Commission. Such portions of the report as are of most interest to engineers are given. 7000 w. Eng News—Jan. 26, 1905. No. 67477.

The Revival of De Lesseps' Sea-Level Plan for the Panama Canal. Gen. H. L. Abbot. An examination of hydraulic problems involved in the sea-level scheme, showing its impracticability. 3000 w. Engineering Magazine—Feb., 1905. No. 67504 B.

The Work of the Commission on the Panama Canal. C. E. Grunsky. An authoritative account by a member of the commission of the policy which controls its work and of the results which have been accomplished. 4500 w. Engineering Magazine—Feb., 1905. No. 67510 B.

Reinforced Concrete.

See Civil Engineering, Construction.

Review.

Harbors and Waterways in 1904. A review of the important developments, especially in Great Britain. 3400 w. Engr, Lond—Jan. 6, 1905. No. 67204 A.

River Improvement.

Technical Methods of River Improvement as Developed on the Lower Missouri River, by the General Government, from 1876 to 1900. S. Waters Fox. Gives a brief description of the river, and of the more important works. Ills. 17,000 w. Pro Am Soc of Civ Engrs—Jan., 1905. No. 67502 E.

River Protection.

The Protection Works of the Banks of the Sutlej, British India (Travaux de Protection des Rives du Sutlej). G. Richon. Describing the dikes erected for the protection of the Kaiser-i-Hind bridge. 1800 w. 1 plate. Génie Civil—Dec. 17, 1904. No. 67308 D.

Shore Protection.

Shore Protection Works in Holland (Seeuferbauten in Holland). H. v. Horn. Illustrating and describing the dikes and protection works at the island of Walcheren, and the dunes at Pettem. 1800 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst — Dec. 17, 1904. No. 67382 D.

The Essex Levels and Sea Walls. An illustrated article describing marsh protection and giving the history of the Essex levels, and the method of building new walls or dikes. 4500 w. Public Works—Jan., 1905. No. 67468 F.

Stream Regulation.

Steam Regulation in Upper Austria (Die Gewässerregulierung in Oberösterreich). S. Stern. Plans and illustrations of a number of mountain streams and the works constructed for their control. 4000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Dec. 31, 1904. No. 67384 D.

Thames Barrage.

The Thames Barrage Scheme. Discusses a measure to be introduced for the consideration of Parliament which provides for endocking the river by the construction of a barrage between Gravesend and Tilbury. 3000 w. Builder—Jan. 14, 1905. No. 67427 A.

Wharf.

The London, Brighton, and South Coast Railway Company's Deptford Wharf. Illustrated description of the recent installation of electric cranes. 2800 w. Engng—Jan. 13, 1905. No. 67452 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Automatic Telephony.

Some Latest Features of Automatic Telephony. Norman G. Meade. An explanation of the more important points of the automatic system, giving diagrams showing the various circuits and details. 2200 w. Elec Wld & Engr—Dec. 31, 1904. No. 66989.

Cables.

The Manufacture of Air-Insulated Cables. Emile Guarini. Illustrates and describes the process at Messrs. Siemens & Halske's cable works, at Nonnendamm, where air is used as an insulating medium in connection with the manufacture of telephone cables. 1000 w. Elec Rev, N Y—Jan. 21, 1905. No. 67291.

Recorder.

The Orling-Armstrong Electro-Capillary Recorder. Illustrated detailed description of this apparatus and its operation. It is peculiarly adapted for cable work. 1700 w. Sci Am Sup—Jan. 21, 1905. No. 67288.

Space Telegraphy.

A New American System of Wireless Telegraphy. A. Frederick Collins. Describes the system of James Foster King. Ills. 2500 w. Elec Wld & Engr—Jan. 21, 1905. No. 67425.

Can the Receiver Distinguish Between the two Forms of Transmitted Waves? (Lässt sich in der Drahtlosen Telegraphie der Empfänger auf die Beiden Wellen des Senders. Abstimmen). Dr. George Seibt. A discussion of the behaviour of various forms of receivers for space telegraphy. 2500 w. Elektrotech Zeitschr—Dec. 29, 1904. No. 67364 B.

The Effect of Subdivision of Spark Gap and Capacity upon Damping (Ueber den Einfluso der Unterteilung einer Funkenstrecke und der Kapcität auf Funkenentladungen). Dr. G. Benischke. An examination of Slaby's method of tuning in connection with the behaviour of insulators and lightning arresters. 3000 w. Elektrotech Zeitschr — Jan. 5, 1905. No. 67366 B.

The Tuning of Transmitters for Space Telegraphy (Die Abstimmung Funkentelegraphischer Sender). A Slaby. A discussion of the selective tuning of directly excited transmitters by a regulation of the spark gap resistance. 7500 w. Elektrotech Zeitschr—Dec. 22, 1904. No. 67360 B.

Statistics.

Statistics of the Telephone and Telegraph Industries. Information from a Census bulletin on telephony and telegraphy for the year ending Dec. 31, 1902. 2700 w. Elec Wld & Engr—Jan. 21, 1905. Serial. 1st part. No. 67422.

Telegraphone.

The Telegraphone. Dr. Z. B. Babbitt. An interesting description of this invention of Valdemar Poulsen, its workings and the uses to which it may be applied. 1600 w. Jour Fr Inst—Jan., 1905. No. 67244 D.

Telegraphy.

Direct Wheatstone Working Between England and Teheran. T. W. Stratford-Andrews. Technical description, with notes, map and diagram of connections, at London station. 2800 w. Elect'n, Lond—Jan. 13, 1905. No. 67437 A.

Telephony.

Some Interesting Phases of Long-Distance Telephony. S. G. McMeen. An interesting discussion, touching upon simultaneous telephony and telegraphy, long-distance trunks, booster batteries, ticket-tube system, etc. General discussion. Diagrams. 9200 w. Jour W Soc of Engrs—Dec., 1904. No. 67258 D.

Transmitter.

The Kotyra Transmitter (Le Transmetteur Kotyra). R. Wittebolle. Describing an improved keyboard transmitter for the rapid sending of Morse characters over a telegraph wire. 2000 w. Revue Technique—Dec. 25, 1904. No. 67318 D.

DISTRIBUTION.

Cables.

The Charging of a Cable Through a Condenser and Resistance. Oliver Heaviside. The object of the article is to promote the study of special cases numerically and graphically, especially as regards the inclusion of the self-induction of the cable. 2800 w. Elect'n, Lond—Dec. 23, 1904. No. 66997 A.

Conduits.

The Municipal Conduit System of Erie, Pa. Benjamin E. Briggs. Map and sections, with description of underground conduits for electric wires and cables. 2500 w. Munic Engng — Jan., 1905. No. 67217 C.

Fuses.

The Uncertainty of Fuses. Considers

some of the causes of uncertainty, with remarks on the recent researches of Oelschlager. 1500 w. Elec Rev, Lond—Dec. 30, 1904. No. 67132 A.

Protection.

Protection Devices for High-Tension Overhead Wires (Schutzvorrichtung für Starkstromleitungen mit Oberirdischer Stromzuführung). Fr. Krizik. Especially describing arrangements of guard wires for the protection of telegraph and telephone wires from contact with overhead trolley wires. 1200 w. Zeit f Elektrotechnik—Dec. 18, 1904. No. 67371 D.

Relays.

Discriminating Relays and Cut-Outs. M. B. Field. Deals with wattmeter relays, and briefly considers compound differential devices. Ills. 2000 w. Elec Rev, Lond—Jan. 13, 1905. No. 67435 A.

Switches.

Distance-Control Switches and Their Lay-Outs in Stations. W. E. Warrilow. Deals with the chief types of oil switches in use, their design and assembly in conjunction with other apparatus to form a power-house or substation switchgear. 2000 w. Elec Engr, Lond—Jan. 6, 1905. Serial. 1st part. No. 67195 A.

Wire Stresses.

The Calculations of Sag and Stresses in a Freely Stretched Wire (Beitrag zur Berechnung des Durchhangs und der Spannung von Frei Gespannten Drähten). A. Löwit. Giving formulas and diagrams for the stresses in an overhead wire for various spans and sags. 800 w. Zeit f Elektrotechnik — Dec. 18, 1904. No. 67370 D.

ELECTRO-CHEMISTRY.

Dry Battery.

Practical Experience in Dry Battery Construction (Trockenelementbau nach Praktischen Versuchen). Walther Stöckigt. A brief, clear description of the general construction of successful working dry batteries. 1200 w. Elektrochem Zeitschr—Dec., 1904. No. 67372 G.

Electric Smelting.

The Froges-Heroult Electro-Metallurgical Process (Procédé Electro-Métallurgiques Froges-Héroult). Ch. Combes. A description of the manufacture of steel by the Héroult electric process at La Praz. 3000 w. L'Electrochimie—Dec., 1904. No. 67391 D.

The Neuburg-Minet Electric Furnace for the Production of Iron and Steel. Dr. Albert Neuburger and A. Minet. Illustrates and describes an electrical furnace for which it is claimed that the process may be carried out with small consumption of electricity, and that the electricity may be generated cheaply, and allows of the use of cheap waste gases in the manufacture. 2000 w. Min Jour—Dec. 31, 1904. No. 67123 A.

Electrolysis.

The Electrolytic Separation of Metals (Die Elektrolytische Fällung der Metalle). Arthur Fischer and R. J. Boddaert. Discussing especially the effect of an active agitation of the electrolyte in the separation of the more important metals. 4000 w. Zeitschr f Elektrochemie—Dec. 23, 1904. No. 67373 D.

Resistance Furnaces.

Miscellaneous Accessories of Resistance Furnaces. F. A. J. Fitz Gerald. Discusses principally means for regulating the voltage and methods of electrode connections. 4000 w. Elec-Chem & Met Ind—Jan., 1905. No. 67105 C.

Review.

Progress in the Electrochemical and Electrometallurgical Industries in 1904. John B. C. Kershaw. Gives some details of new processes and reviews the position of the older industries during the year. 2000 w. Elec Rev, N Y—Jan. 14, 1905. No. 67170.

Zinc Coatings.

Investigation of the Properties of Zinc Coatings. Charles F. Burgess. A report of investigations undertaken at the University of Wisconsin to determine, if possible, the relative value of zinc deposited by the electrolytic or "cold" processes and the metal as applied by the "hot" or dipping methods. 5000 w. Elec-Chem & Met Ind—Jan., 1905. No. 67107 C.

ELECTRO-PHYSICS.

Magnetism.

The Theory of Magnetism (Sur la Theorie du Magnetism). P. Langevin. An examination of the corroboration of Curie's laws by the theory of electrons. 900 w. Comptes Rendus—Dec. 26, 1904. No. 67325 D.

Thermo-Electricity.

The Thermo-Electricity of Aluminum Alloys (Sur la Thermo-Electricité des Alliages d'Aluminium). Hector Pécheux. Data and results of tests upon alloys of aluminium with tin, lead, bismuth, magnesium, antimony and zinc. 700 w. Comptes Rendus—Dec. 26, 1904. No. 67324 D.

Voltage.

The Rise of Pressure in Electric Conductors and Apparatus (Ueber Spannungserhöhungen in Elektrischen Leitungen und Apparaten). Dr. Georg Seibt.

An examination of the momentary rise in voltage which occurs upon the making or breaking of an electrical contact. 4000 w. Elektrotech Zeitschr—Jan. 12, 1905. No. 67368 B.

GENERATING STATIONS.

Alternators.

Design of Alternators. A. Press. Gives formulas and explanation. 600 w. Elec Rev, Lond—Dec. 23, 1904. No. 66998 A.

Antwerp.

The Power House of the Antwerp Electric Tramways (Station Centrale des Tramways Electriques d'Anvers). A general description, with photographs of the engines, and section of the building. There are three generating sets, of 1200 h.p. each. 1200 w. Génie Civil—Dec. 17, 1904. No. 67307 D.

Boston.

Modern Central Station Design as Exemplified by the New Turbo-Generator Station of the Edison Electric Illuminating Company of Boston. I. E. Moultrop. An illustrated detailed description of this station and its equipment. 5700 w. Pro Am Inst of Elec Engrs—Jan., 1905. No. 67261 D.

British Practice.

The Tendency of Practice in Power Station Engine and Boiler Plant. Francis H. Davies. Reviews the development of steam and electricity supply in England, particularly noting the difference that has existed in horse power installed between the leading types of boilers and engines at various periods during the last few years. 1200 w. Elec Rev, Lond—Dec. 30, 1904. No. 67128 A.

Commutators.

Repairing Commutators. Norman G. Meade. Gives detailed instructions for repairing and refilling commutators with the facilities that may be found in a manufacturing plant. Ills. 1800 w. Power—Jan., 1905. No. 67022 C.

Compounding.

Compensated Alternate Current Generators. Miles Walker. Abstract of a paper read at Manchester, Eng., before the Inst. of Elec. Engrs. Describes some methods of compensating, especially the method of the author which preserves the field excitation constant and utilizes the armature field to raise the voltage. Ills. 3000 w. Elec Rev, Lond—Dec. 30, 1904. No. 67131 A.

Destructor Plant.

The Combination of Dust Destructors and Electricity Works Economically Considered. Frank Broadbent. A critical review of a recent paper by W. P. Adams on the above subject. 2700 w. Elec Rev, Lond—Dec. 23, 1904. No. 66999 A.

Dynamos.

Acyclic (Homopolar) Dynamos. J. E. Noeggerath. Describes in outline the design, and some results obtained with, a 300-kw. 500-volt turbine-driven acyclic generator, discussing the uncertainty as to the magnetic and electrical conditions prevailing in this type, and the difficulties encountered in collecting large currents from a generator running at a high rate of speed. Ills. 1800 w. Pro Am Inst of Elec Engrs—Jan., 1905. No. 67260 D.

Eccentricity.

The Determination of the Magnetic Pull in Cases of Eccentricity (Berechnung des Einseitigen Magnetischen Zuges bei Exzentrizität). J. K. Sumec. Deriving formulas for the computation of the one-sided pull for a given eccentricity of rotor in a dynamo. 1000 w. Zeit f Elektrotechnik—Dec. 18, 1904. No. 67369 D.

Gas Power.

Some Continental Central Stations Operating with Gas Engines. Franz Koester. An illustrated article describing a few of these stations. 3500 w. Elec Rev, N. Y.—Jan. 14, 1905. No. 67172.

Hydro-Electric.

Canadian Niagara Power To-Day. An illustrated description of the fine plant of this company. 2500 w. Elec Wld & Engr —Jan. 7, 1905. No. 67093.

Duluth Hydro-Electric Development. Dwight E. Wooodbridge. Illustrates and describes the project for the improvement of the water power of the St. Louis River, at the head of Lake Superior. 1800 w. Ir Age—Jan. 19, 1905. No. 67271.

Electric Power for Minnesota Ore Roads. An illustrated account of an important power development on the St. Louis River. It furnishes power for mines and ore roads, and for the city of Duluth. 2000 w. Ir Trd Rev—Jan. 12, 1905. No. 67103.

Electrical Power from the Welland Canal. An illustrated detailed description of the development which provides power for Hamilton, Canada, and other places in the locality. 2500 w. Elec Wld & Engr —Jan. 21, 1905. Serial. 1st part. No. 67423.

Hydro-Electric Power Plant at Turbigo. Illustrates and describes this recently completed plant. 1500 w. Engr, Lond—Dec. 23, 1904. No. 67019 A.

Hydro-Electric Power Plants in the Canadian Niagara District. Cecil B. Smith. A fully illustrated account of the plant recently erected on the Canadian side of the Niagara River with an ultimate capacity of 400,000 horse power. 5000 w. Engineering Magazine—Feb., 1905. No. 67505 B.

Morgan's Falls, Ga., Transmission Plant. Lamar Lyndon. Illustrates and describes a plant costing nearly a million and a half dollars, and having a capacity of 14,000 H. P. 2500 w. Elec Wld & Engr—Dec. 31, 1904. No. 66990.

St. Joseph River Power Development. Illustrated description of a system which will furnish power to northern Indiana and southern Michigan. 1400 w. Elec Wld & Engr—Dec. 31, 1904. No. 66988.

Typical American Hydraulic and Transmission Plant. C. W. Whitney. Illustrated detailed description of the American River Electric Company's system in central California. 6800 w. Am Elect'n—Jan., 1905. No. 67036.

Omaha.

Electric Supply in the Gate City. Alton D. Adams. An illustrated account of the service in Omaha. 2000 w. Elec Rev, N. Y.—Jan. 14, 1905. No. 67173.

Power Supply.

Electric-Power Supply from Central Stations in Great Britain. G. L. Addenbrooke. A complete survey of the projects under consideration, with illustrated descriptions of the South Wales, Newcastle, Thornhill, and other power stations. 5000 w. Engineering Magazine—Feb., 1905. No. 67507 B.

Regulation.

The Electro-Mechanical Control of Electric Generating Sets (Compoundage Electro-Mécanique des Groupes Electrogènes). M. De Kermond. A description of the Routin method of regulation by controlling the excitation of the dynamo and the speed of the engine. 3000 w. L'Electricien—Dec. 24, 1904. No. 67386 B.

The Routin Electro-Mechanical Regulator (Das Elektromechanische Reguliers-system von Routin). F. Brock. By means of an auxiliary dynamo the excitation of the generator is varied with the load, and the weighting of the engine governor is altered. 1500 w. Elektrotech Zeitschr—Dec. 22, 1904. No. 67362 B.

Statistics.

Statistics of Generating Stations in Germany (Statistik der Elektrizitätswerke in Deutschland). The annual tabular review of the electric power and lighting stations in the German empire, with summary and review in comparison with preceding years. 20000 w. Elektrotech Zeitschr—Jan. 12, 1905. No. 67367 B.

See also Street and Electric Railways.

LIGHTING.

Dublin.

The City of Dublin Electric Lighting. An illustrated detailed description of the arc-lighting. 1100 w. Engng—Dec. 30, 1904. No. 67138 A.

Lighting Stations.

See Electrical Engineering, Generating Stations.

Mercury Vapor.

The Mercury-Vapor Lamp and Mercury Vacuum Devices (Die Quecksilberlampe und sonstige Quecksilber-Vakuumapparate). Max von Recklinghausen. Discussing the Cooper-Hewitt lamp and the applications of the device as a current rectifier. 4500 w. Elektrotech Zeitschr—Dec. 22, 1904. No. 67363 B.

Nernst Lamps.

City Street Lighting at Sewickley, Pa., a Successful Six-Glower Nernst Lamp System. Brief illustrated description of the first installation of its kind in the United States. 700 w. Elec Rev, N. Y.—Jan. 21, 1905. No. 67292.

Photometry.

See Electrical Engineering, Measurement.

Train Lighting.

Electric Train Lighting in Connection with the Austrian Mail Service (Ueber Elektrische Zugbeleuchtung mit besonderer Berücksichtigung der Oesterreichischen Bahnpostwagen). Karl Wallitschek. A description of the use of accumulators and axle-driven dynamos for lighting the railway post-office cars in Austria. Two articles. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 6, 13, 1905. No. 67336 each D.

The Electric Lighting of Railway Trains. Dr. Alfred Gradenwitz. Illustrates and describes a system designed by Mr. Aichele, and being brought out by the Aktien-Gesellschaft Brown, Boveri & Co. of Baden, Switzerland. Each car has a lighting plant of its own. 3800 w. Elec Engr, Lond—Jan. 13, 1905. No. 67440 A.

MEASUREMENT.

Laboratory Testing.

Alternating Current Laboratory Testing. George H. Rowe. The first of a series of articles based on lectures delivered to students engaged in the experimental study of alternating current phenomena. Experimental investigations. Ills. 1600 w. Jour of Elec—Jan., 1905. Serial. 1st part. No. 67100 C.

Meters.

Electricity Meters. C. H. W. Gerhardi.

A classification and description of electric meters. Ills. 2500 w. Elect'n, Lond—Jan. 6, 1905. Serial. 1st part. No. 67197 A.

Photometry.

Photometry for Central Station Engineers. Lancelot W. Wild. Describes how photometric measurements may be made in a central station both accurately and quickly, and without employing any very expensive apparatus, nor a specially skilled testing staff. 1500 w. Elec Rev, Lond—Jan. 6, 1905. No. 67196 A.

Potentiometer.

A Multiple-Dial Potentiometer. Albert Campbell. Describes a low-resistance instrument, aiming at ease of mechanical construction, accuracy, convenience of reading, and compactness. 400 w. Elec Rev, Lond—Dec. 30, 1904. No. 67130 A.

Testing.

The Electrical Testing Laboratories. Clayton H. Sharp. An illustrated description of the plant in New York, on the corner of 80th St. and East End Ave., and of its equipment for the work. 5200 w. Elec Wld & Engr—Jan. 7, 1905. No. 67096.

MOTORS.

Balancers.

On Direct-Current Balancers. A. E. Kennelly and S. E. Whiting. Aims to express the fundamental conditions of operation of such balancers in a form adapted for use in electric driving. Diagrams. 1500 w. Elec Wld & Engr—Jan. 17, 1905. No. 67097.

Commutation.

Commutation at Starting of Alternating-Current Motors with Commutator. Marius Latour. Discusses a special construction for commutator armatures, in which resistance leads are used between the winding and the commutator, in connection with the starting of the single-phase motor. 1200 w. Elec Wld & Engr—Jan. 14, 1905. No. 67186.

Controller.

Apparatus for Starting and Controlling Electric Motors (Dispositif de Mise en Marche et de Changement de Marche pour Electro-Moteurs). Illustrating and describing an improved form of controller. 1800 w. L'Electricien—Jan. 14, 1905. No. 67388 B.

Electric Driving.

Electric Driving of Textile Mills. W. B. Woodhouse. States briefly the advantages of electrical driving, with some facts on the cost of driving by motors, taking a supply from the mains of a power company or electricity works. 3300 w. Elect'n, Lond—Jan. 6, 1905. No. 67198 A.

Electric Power in French Gas Works. Illustrates and describes the construction and methods of operating electrically-operated machines for charging retorts and removing coke. 800 w. Elec Wld & Engr—Jan. 21, 1905. No. 67424.

The Electrical Equipment of the New York "Times" Building. Explains reasons for taking the supply of current from the N. Y. Edison Co. and describes the service, applications, &c. Ills. 1700 w. Elec Rev, N. Y.—Jan. 28, 1905. No. 67518.

The Thompson-Ryan Motor and Its Application to Machine Tools. An illustrated description of an electric motor giving wide speed range by means of field control. 3300 w. Ir Age—Jan. 5, 1905. No. 67004.

Electric Vehicles.

See Mechanical Engng., Automobiles.

Induction Motors.

The Determination of Straying and the Measurement of the Constants for Idle Running for Induction Motors (Streuungsmessung an Drehstrommotoren und Bestimmung der Leerlaufskonstanten). Robert Moser. A general mathematical treatment, making use of the vector analysis. 5000 w. Elektrotech Zeitschr—Jan. 5, 1905. No. 67365 B.

Loads.

Stand-by Charges and Motor Load Development. A. M. Taylor. A short abstract of a paper read before the Birmingham Local Sec. of the Inst. of Elec. Engrs. Also discussion. Gives a method of determining the actual cost of the load at any time of the day. 4000 w. Elec Engr, Lond—Jan. 13, 1905. No. 67444 A.

Steering.

See Marine and Naval Engineering.

TRANSMISSION.

Lightning.

Lightning Protection. Killingworth Hedges. Illustrated description of special clamps designed by the writer which project from the wall, and of methods of installation adopted. 1600 w. Public Works—Jan., 1905. No. 67463 F.

The Gola Lightning Arrester (Parafoudre Système Gola). J. A. Montpellier. Describing an improved arrangement of series lightning arrester, applicable for currents up to 30,000 volts and 250 amperes. 800 w. L'Electricien—Jan. 7, 1905. No. 67387 B.

Line.

New 30,000-Volt, Steel Pole, Long

Span, Transmission Line. Describes the line from Los Angeles to Inglewood, a distance of fourteen miles. Ills. 1500 w. Jour of Elec—Jan., 1905. No. 67102 C.

Lombardy, Italy.

The First Transmission of Power in Europe at 40,000 Volts. Enrico Bignami. Illustrated description of the electric transmission system from Gromo to Nembro, in Lombardy. 2400 w. Elec Rev, N. Y.—Jan. 7, 1905. No. 67040.

Space Transmission.

The Transmission of Electrical Energy Without Works as a Means for Furthering Peace. Nikola Tesla. A lengthy article explaining the writer's views and his belief in the possibility of the economic transmission of power without wires. 4800 w. Elec Wld & Engr—Jan. 7, 1905. No. 67094.

Switches.

High-Tension Switch Gear. L. Andrews. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses methods of control, the devices used, &c. Brief general discussion. 2200 w. Elect'n, Lond—Dec. 30, 1904. No. 67133 A.

High-Tension Switchgear. L. Andrews. Read before the Manchester Sec. of the Inst. of Elec. Engrs. The present article considers mechanical v. electrical remote control, separation of phases in circuit breakers, discriminating circuit breakers, &c. 2500 w. Mech Engr—Jan. 7, 1905. Serial. 1st part. No. 67193 A.

MISCELLANY.

India.

Electricity in India and Burma. E. C. Deepholt. A brief account of the gradual progress of electricity at the present day and the future outlook. 2000 w. Elec Engr, Lond—Jan. 13, 1905. No. 67441 A.

Review.

Electrical Engineering in 1904. Principally a review of the industry in England. 4800 w. Engr, Lond—Jan. 6, 1905. No. 67206 A.

Electricity in 1904. A review of the progress made in electrical science and arts during the past year. 2700 w. Elec Rev, N. Y.—Jan. 14, 1905. No. 67168.

Review of the Year in Great Britain and the Continent of Europe. C. L. Durand. A general review of the progress in electric traction and other electrical industries. 3200 w. Elec Rev, N. Y.—Jan. 14, 1905. No. 67171.

INDUSTRIAL ECONOMY

Copper Trade.

The American Copper Trade. Horace J. Stevens. Information concerning the sources of supply, the features of individual mines, foreign trade, &c. 3000 w. Ir Age—Jan. 5, 1905. No. 67008.

Cost Keeping.

Cost Keeping in an English Machine Tool Works. J. William Chubb. An account of a system put in practice by an English firm, and planned by Mr. Charles Taylor, of Birmingham. 2500 w. Am Mach—Vol. 28, No. 4. No. 67473.

Methods of Figuring Costs. C. E. Bement. Read before the Mich. Engng. Soc. Explains briefly the method used in a shop manufacturing "gang plows." 1800 w. Eng Rec—Jan. 21, 1905. No. 67405.

Gold Production.

See Mining and Metallurgy, Gold and Silver.

Iron Trade.

The Present State and Outlook of the Iron Trade in Spain. A report of progress, with a discussion of the industry and its possibilities. 2800 w. Ir & Coal Trds Rev—Jan. 6, 1905. Serial. 1st part. No. 67208 A.

Metal Markets.

Lead, Copper, and Tin in 1904. E. A. Caswell. Reviews the features of the market during the year. 3800 w. Ir Age —Jan. 5, 1905. No. 67003.

Patent Laws.

The United States Patent Laws. Historically and Practically Considered. Cyrus N. Anderson. Reviews briefly early English laws relating to patents, and discusses the laws enacted by the United States Government. 5000 w. Jour Fr Inst—Jan., 1905. No. 67247 D.

Prizes.

The Prizes Awarded by the French Academy for 1904 (Prix Décernés Année 1904). The reports of the various committees of the *Académie des Sciences*, announcing the awards of the prizes. 20000 w. Comptes Rendus—Dec. 19, 1904. No. 67321 D.

Silver Production.

See Min. and Metallurgy, Gold & Silver.

Specifications.

Engineers' Specifications. Observations on specifications in general and the legal effect of clauses of particular hardship to contractors. 3200 w. Engr, Lond—Dec. 30, 1904. No. 67142 A.

Tin Plate.

The Sheet and Tin Plate Industries. B. E. V. Luty. Discusses the demand and supply, the price movement, wage matters, &c. 4000 w. Ir Age—Jan. 5, 1905. No. 67001.

Wages.

Capital and Labor in America (Kapital und Arbeit in Amerika). M. A. Nüscheler. Discussing especially methods of determining wages, including day work, piece work, and the premium and contract systems. 3000 w. Glasers Annalen—Jan. 1, 1905. No. 67329 D.

Dealing with the Unemployed. J. Keir Hardie. A discussion of this problem, outlining the scope of voluntary agencies for dealing with distress and the reforms necessary. Refers especially to England. 8000 w. Nineteenth Cent—Jan., 1905. No. 67210 D.

MARINE AND NAVAL ENGINEERING

Battleship.

Machinery of the Italian Battleship Regina Margherita. Illustrated detailed description of the vessel and its equipment, with report of trials. 2000 w. Engr, Lond—Jan. 6, 1905. No. 67207 A.

Cargo Steamer.

Stone Handling Plant of the Lake Shore Stone Co., Belgium, Wis. Illustrates a stone-carrying steamer, equipped with mechanical conveyors for unloading the cargo, and describes the methods of loading at the quarry. 2000 w. Eng News—Jan. 19, 1905. No. 67285.

Conning Tower.

The Conning Tower of a War Ship (La Torra di Comando nelle Navi da Guerra). Edwin Cerio. A criticism of present conning towers on various battle ships, with suggestions for improvements by subdivision. 2500 w. Rivista Marittima—Dec., 1904. No. 67357 H.

Engines.

See Mechanical Engineering, Steam Engineering.

Floating Crane.

A New One-Hundred Ton Floating Crane. Illustrates and describes this powerful machine for the New York Navy Yard, and gives an account of some of the work it has already accomplished. 2000 w. Marine Engng—Jan., 1905. No. 67030 C.

Motor Boats.

A Twelve-Cylinder 150-B. H. P. Racing Marine Gasoline Motor. Illustration, with detailed description. 1500 w. Sci Am Sup—Jan. 28, 1905. No. 67500.

A Two-Stroke Marine Motor. Illustrates and describes the Webster and Bickerton four-cylinder, two-cycle marine motor, with open type cranks, and magneto high-tension ignition. It can be used for other purposes and will work on paraffin. 1600 w. Autocar—Jan. 14, 1905. No. 67432 A.

Improved Speed-Change Gear for Motor Boats (Nouveau Changement de Marche Progressif pour Canots à Petrole). A description of the Julien gear for enabling a gradual change of speed for the propeller of a motor boat driven by a gasoline motor. 1800 w. Revue Technique—Dec. 25, 1904. No. 67319 D.

Motor Lifeboats. W. G. Windham. States some of the advantages and disadvantages of a petrol engine as fitted to a life boat, giving some practical hints on the fitting of a motor. Ills. 2000 w. Autocar—Dec. 31, 1904. No. 67125 A.

Powering.

Powering Ships. Edwin Cerio. An explanation of the methods of investigation both mathematical and experimental, for determining the resistance of ships. Marine Engng—Jan., 1905. Serial. 1st part. No. 67034 C.

Propellers.

Practical Points About the Screw Propeller. W. F. Durand. Discusses the design, construction and operation of screw propellers for marine propulsion. Ills. 2800 w. Marine Engng—Jan., 1905. Serial. 1st part. No. 67032 C.

The Size of Screw Propeller Blades (La Grossezza delle Pale d'Elica). N. Pecoraro. An examination of the efficiency of screw propellers in connection with the effective portion of the surface of the blades. 4000 w. 6 plates. Rivista Marittima—Nov., 1904. No. 67356 H.

Steering.

Electric Steering Control of Ships. Illustrated detailed description of the installation on the naval ship "Baden." 1600 w. Marine Engng—Jan., 1905. No. 67033 C.

Survey Steamer.

Coast & Geodetic Survey Steamer Pathfinder. Illustrated description of this vessel and its equipment. 2500 w. Marine Engng—Jan., 1905. No. 67035 C.

Torpedo Boats.

Some Points of Interest in Torpedo-Boat Construction. Harold E. Yarrow. Read before the Junior Inst. of Engrs., London. Briefly discusses the hull, riveting, vibration, lubrication, steam pipes, &c. 2500 w. Naut Gaz—Jan. 12, 1905. No. 67162.

Troopship.

Trials of the Troopship "Dufferin." Gives a report of the steam trials, and describes some of the special fittings. 1000 w. Engng—Dec. 30, 1904. No. 67139 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Alcohol.

Alcohol as a Fuel for Motor Cars. An interview with Dr. Ormondy, discussing why alcohol is not more generally used, its advantages, the working of the alcohol engine, &c. 2300 w. Autocar—Jan. 14, 1905. No. 67433 A.

American Car.

A New American Automobile. Illustrated description of the Christie racer. 1200 w. Sci Am—Jan. 28, 1905. No. 67497.

Exhibitions.

Features of Leading Cars at Paris Show. An illustrated article describing changes for the season of 1905 in the construction of frames, engines, clutches, carbureters, and control systems. 4500 w. Automobile—Dec. 31, 1904. No. 66972.

Fifth Annual Show in New York. An illustrated general description of the exhibits and interesting features. 6200 w. Automobile—Jan. 21, 1905. No. 67299.

Foreign Cars.

Foreign Automobiles at the Importers' Salon. Illustrations, with brief descriptions, of cars exhibited at the Macy Building, in New York. 2000 w. Sci Am—Jan. 28, 1905. No. 67494.

Garages.

Heating and Ventilation of Garages. N. B. Pope. Suggestions for small garages and private motor-houses. 1400 w. Motor-Car Jour—Jan. 14, 1905. No. 67426 A.

Gasoline Truck.

A Gasoline Truck Driven by All Four Wheels. Illustrated description. 800 w. Sci Am—Jan. 28, 1905. No. 67495.

Locomotive.

See Railway Engineering, Motive Power.

Mercedes.

The 1905 70 H. P. Mercedes Car. Illustrated description of the latest type of Mercedes car. 1200 w. Autocar—Dec. 24, 1904. No. 67013 A.

Oils.

See Mechanical Engineering, Materials.

Omnibuses.

The Straker-Squire Petrol Omnibuses and Commercial Vehicles. Illustrated description, giving full particulars of these vehicles. 2500 w. Auto Jour—Jan. 14, 1905. Serial. 1st part. No. 67431 A.

Powering.

Power Calculations for Electric Vehicles. H. H. Kennedy. Suggestions for calculating the power equipment of a vehicle propelled by storage batteries and electric motors. 1200 w. Am Mach—Vol. 28, No. 2. No. 67099.

Recent Models.

Some Leading Automobiles of the Present Year. Brief descriptions, with illustrations. 2200 w. Sci Am—Jan. 28, 1905. No. 67492.

Siddeley.

The 12 H. P. Two-Cylinder Siddeley Car. Illustrated detailed description of a car which has recently started on a 5,000 miles officially observed tour. 1500 w. Autocar—Jan. 7, 1905. No. 67191 A.

Speed Gear.

How a Change Speed Gear Works. Illustrates and describes the working of the gear fitted to the Panhard-Levassor cars. 1000 w. Autocar—Jan. 7, 1905. No. 67190 A.

Sunbeam.

The Sunbeam 12 H. P. Car. Illustrated description of a chain-driven car which has the whole of the transmission entirely protected. 1300 w. Autocar—Dec. 31, 1904. No. 67124 A.

Suspension.

Automobiles with Three Axles (Automobiles à Trois Essieux). Lt. Col. G.

Espitallier. A description of the Lindecker system of suspension for heavy vehicles, using three axles and equalizing levers. 2000 w. Génie Civil—Dec. 31, 1904. No. 67312 D.

Touring Cars.

Model C National Touring Car. An illustrated description of an attractive gasoline touring car of recent design. 1500 w. Automobile—Jan. 7, 1905. No. 67055.

The National Touring Car. Illustrated detailed description. 1800 w. Sci Am—Jan. 28, 1905. No. 67496.

The New Ardsley Touring Car. An illustrated detailed description of an "assembled" car which is reported superior to many "one shop" products. 3000 w. Automobile—Jan. 7, 1905. No. 67054.

Typical American Touring Cars for 1905. Illustrated descriptions of various types. 5700 w. Sci Am—Jan. 28, 1905. No. 67493.

See also Mechanical Engineering, Combustion Motors.

COMBUSTION MOTORS.

Current Practice.

Current Practice in Combustion Engines. Brief illustrated descriptions of the more important features of various engines. 12800 w. Engr, U. S. A.—Jan. 1, 1905. (Special.) No. 67116 D.

Diesel.

The American Diesel Engine. Norman M'Carty. Brief description of the principle on which the engine works. Ills. 1800 w. Engr, U. S. A.—Jan. 1, 1905. (Special.) No. 67117 D.

The Diesel Engine in Electricity Generating Stations. A. J. Lawson. Abstract of a paper read before the Glasgow Tech. College Sci. Soc. Gives the results of actual experience of the working of such engines over a considerable period. 2000 w. Elect'n, Lond—Jan. 13, 1905. No. 67438 A.

Gas Engines.

European Gas Engine Practice. A. H. Allen. Considers the main features of the more recent designs of engines, and also the producer plants. 3000 w. Engr, U. S. A.—Jan. 1, 1905. (Special.) No. 67112 D.

Experience with Large Gas Engines. Abstract of an address by Herr Strack, translated from *Stahl und Eisen*. Describes the gas engines used, and gives an account of their working. 2800 w. Ir Age—Jan. 19, 1905. No. 67270.

Gas Engine Economy. Charles Edward Lucke. The present article is introductory; remarks on the importance of economy. 1200 w. Engr, U. S. A.—Jan. 1, 1905. Serial. 1st part. (Special.) No. 67115 D.

Gas Engines in Power Plants. William T. Magruder. Abstract of a paper read before the Ohio Soc. of Mech., Elec., and Steam Engrs. Arguments for the use of gas engines. 2500 w. Engr, U. S. A.—Jan. 1, 1905. (Special.) No. 67114 D.

Governing Large Gas Engines. Charles S. Sage. Discusses the requirements of a controlling device that will give the best possible efficiency. 4500 w. Power—Jan., 1905. No. 67020 C.

Producer Gas Engines on Shipboard. A. Sinn. An illustrated article discussing the best gas engine practice and its adaptability for use on ships. 3000 w. Marine Engng—Jan., 1905. No. 67031 C.

The Development of the Gas Engine and Its Application to Electric Central Station Service. R. T. MacKeen. Gives a comparative idea of the relative efficiency of steam engines and gas engines, and considers in detail the principle of the gas engine and the gas producer. 3200 w. Can Elec News—Jan., 1905. No. 67400.

The Development of the Gas Engine. Albert Stritmatter. Reviews the history of the development. 2000 w. Engr, U. S. A.—Jan. 1, 1905. (Special.) No. 67111 D.

Gas Power.

See Electrical Engineering, Generating Stations.

Gas Turbine.

The Stolze Gas Turbine Engine. Dr. Alfred Gradenwitz. Particulars of this turbine, with illustrations. 900 w. Autocar—Dec. 31, 1904. No. 67126 A.

Igniters.

Electric Igniters for Gas Engines. George M. Hopkins. An illustrated article showing the principle of the electric igniter. 1200 w. Sci Am Sup—Jan. 7, 1905. No. 67028.

Locomotive.

See Railway Engineering, Motive Power.

Motor Boats.

See Marine and Naval Engineering.

Oil Engines.

Petroleum and Petrol Engines. Illustrates and describes the high-speed vertical engines manufactured by L. Gardner & Sons, Ltd., near Manchester, England. Describes a portable plant. 1500 w. Engr, Lond—Jan. 13, 1905. No. 67459 A.

Pumps.

See Mech. Engineering, Hydraulics.

Suction Gas.

A General Description of Suction-Gas Plants (Iets over Zuiggas-installatien in het Algemeen). H. A. Ravenek. With illustrations and description of suction gas apparatus, and an account of the installation at Scheveningen. 4500 w. De Ingenieur—Dec. 10, 1904. No. 67350 D.

An Interesting Producer-Gas Plant. Emile Guarini. Brief illustrated description of the Maystre-Ledoyen suction producer-gas plant in Paris. 600 w. Sci Am Sup—Jan. 28, 1905. No. 67498.

Gas Producer Systems. Illustrated detailed descriptions of five or six suction gas producers. 7500 w. Engr, U. S. A. —Jan. 1, 1905. (Special.) No. 67110 D.

Testing.

Gas Engine Testing. H. B. Macfarland. Suggestions for conducting tests, the preparations, running and observation, &c. Ills. 3800 w. Engr, U. S. A.—Jan. 1, 1905. (Special.) No. 67113 D.

See also Mechanical Engineering, Automobiles.

HEATING AND COOLING.

Heating.

Heating and Ventilation. Charles L. Hubbard. Different classes of buildings are described and the apparatus best adapted to each discussed. 3500 w. Am Archt—Jan. 7, 1905. Serial. 1st part. No. 67059.

Hot Water.

The Circulation of Hot Water. John S. Brennan. Read before the Am. Soc. of Heat. & Ven. Engrs. An illustrated explanation of the circulation in radiators of usual and of an improved connection, giving figures of tests of the two styles. 1000 w. Met Work—Jan. 21, 1905. No. 67274.

Hygrometer.

See Mechanical Engineering, Measurement.

Steam Heating.

The Computation of Piping for Low-Pressure Steam Heating (Beitrag zur Berechnung der Dampfleitung von Niederdruckdampfheizungen). F. Gremmels. With especial reference to the loss of pressure for pipes of given diameter and length. Tables and a graphical chart are given. 3000 w. 1 plate. Gesundheits Ingenieur—Jan. 10, 1905. No. 67355 D.

The Return System of Steam Heating (Dampfanlagen nach dem Kreislaufsystem). Bruno Müller. A general account of the arrangement of steam heating systems in which the condensed steam is returned direct to the boiler. 2500 w. Gesundheits Ingenieur—Dec. 20, 1904. No. 67354 D.

Stoves.

The Escape of Gas from Stoves (Gasausstromungen aus Geheizten Oefen). H. Meidinger. An account of experiments with a model upon the conditions which cause the escape of deadly gases from warming stoves. 2500 w. Gesundheits-Ingenieur—Nov. 20, 1904. No. 67352 D.

Ventilation.

Plenum Ventilation Systems (Ueberdruck-Lüftungsanlagen). Richard Hofmann. A brief discussion of the superior economy of the plenum method of ventilating buildings over an exhaust system. 2000 w. Gesundheits-Ingenieur—Nov. 30, 1904. No. 67353 D.

HYDRAULICS.

Chicago Canal.

Water Power Development on the Chicago Drainage Canal. An illustrated article explaining the general scheme. 1400 w. Eng News—Jan. 12, 1905. No. 67151.

Cranes.

Notes on Cranes—Hydraulic Cranes. A. D. Williams. Briefly describes types. 1000 w. Am Mach—Vol. 28, No. 4. No. 67475.

Flume.

Design of a Steel Water Flume. H. G. Balcom. Considers schemes of design for a steel water flume of approximately 450 sq. ft. cross-section and more than 1,000 feet long. General discussion. 4500 w. Pro Engrs' Soc of W Penn—Dec., 1904. No. 67512 D.

Hydro-Electric Stations.

See Electrical Engineering, Generating Stations.

Meters.

See Mechanical Engineering, Measurement.

Pipes.

The Flexure of the Walls of Conduits of Large Diameter (Flexions des Parois dans les Tuyaux de Conduites de Grand Diametre). C. Birault. A study of the external stresses upon the walls of conduits used for conveying water under pressure for hydraulic power stations. 9000 w. 1 plate. Mem Soc Ing Civ de France—Oct., 1904. No. 67358 G.

Plumbing.

Sanitary Plumbing and Our Plumbing Laws, with Suggestions for Their Revision and Simplification. J. Pickering Putnam. An examination of the plumbing ordinances of Boston, which are similar to the majority of large cities in the

United States, and the explanation of a system embodying most of the amendments advocated. Ills. 6000 w. Tech Qr—Dec., 1904. No. 67420 E.

Pumping.

See Civil Engineering, Water Supply.

Pumps.

A Gas Power Pumping Station for High-Pressure Gas Distribution. Illustrated detailed description of the system of the Laclede Gas Light Co., St. Louis, Mo., explaining the principles embodied. 2200 w. Engr, U. S. A.—Jan. 1, 1905. (Special.) No. 67108 D.

A New Type of Rotary Pump. Emile Guarini. Illustrates and describes a pump which is reversible, and yet gives a true piston stroke like an ordinary pump. 600 w. Sci Am Sup—Jan. 28, 1905. No. 67499.

New Motor Pumps on the Riedler Express System. L. Ramakers. Illustrates and describes a new pump which may be driven by electro-motors, and by benzine, gas, spirit, or petroleum motors, or by belting and transmission shafting. 1200 w. Prac Engr—Jan. 13, 1905. No. 67434 A.

The Hesse Jet Pump. Otto Goldman. Illustrates and describes the invention of Prof. James Thompson, giving calculations of efficiency. 1700 w. Cal Jour of Tech—Nov., 1904. No. 67216 C.

Turbine.

The Largest Water Turbine in Existence. Illustrates the large turbine at Shawinigan Falls, near Montreal, giving brief description. 800 w. Sci Am—Jan. 7, 1905. No. 67026.

Water Wheels.

A Novel Water Wheel. Dr. Alfred Gradenwitz. Brief illustrated description of the "hydrovalve," invented by Prof. Frank Kirchbach, and its operation. 800 w. Sci Am—Jan. 14, 1905. No. 67158.

The Development of the Tangential Wheel in California (Die Entwicklung des Tangentialrades in Kalifornien). Heinrich Homberger. A description of the growth of the use of wheels of the Pelton type, including the recent improvements, such as the Doble needle regulator, etc. 3000 w. Zeitschr d Ver Deutscher Ing—Dec. 17, 1904. No. 67300 D.

MACHINE WORKS AND FOUNDRIES.

Bridge Shop.

The Boston Bridge Works. Illustrates and describes briefly the new shops built on the site of the old ones which were destroyed by fire, and gives details of layout. 4500 w. Eng Rec—Jan. 14, 1905. No. 67176.

Car Wheels.

The Manufacture of Cast Iron Car Wheels. An illustrated description of the system and special appliances used at the new plant of the Pennsylvania Railroad at South Altoona, Pa. 4000 w. Ir Age—Jan. 5, 1905. No. 67000.

Castings.

Direct Casting from the Blast Furnace. Illustrates and describes the methods of production of cast iron tunnel segments as pursued at the works of Thomas Butlin & Co., Ltd., Wellingborough, Scotland. 2000 w. Ir Age—Jan. 12, 1905. No. 67073.

Shrinkage Troubles and Methods of "Feeding." Thomas D. West. Read before the New England Found. Assn. Discusses shrinkage and methods of treating it, difficulties in feeding, and methods. 2700 w. Foundry—Jan., 1905. No. 67237.

Cast Iron.

See Mechanical Engineering, Materials.

Chains.

The Manufacture of Chains. L. B. Powell. Illustrated description of the manufacture of machine made, and of hand made chains, the testing, wear, &c. 4500 w. Ir Age—Jan. 5, 1905. No. 67002.

Core Ovens.

Oil as Fuel for Core Ovens. S. F. Barnes. Read before the Phila. Found. Assn. Describes the system of piping employed in using oil as fuel. Ills. 1500 w. Ir Age—Jan. 19, 1905. No. 67269.

Cost Keeping.

See Industrial Economy.

Drills.

Drills and Drill Making (Bohrer und Bohrerfabrikation). G. Niedecker. A discussion of the action of flat and twist drills, with suggestions as to the best forms and processes of manufacture. Three articles. 4000 w. Zeitschr f Werkzeugmach u Werkzeuge—Nov. 25, Dec. 5, 15, 1904. No. 67395 each D.

Electric Driving.

See Electrical Engineering, Motors.

Engine Building.

A Modern Engine Building Plant. Illustrated description of the large plant of the William Tod Company, at Youngstown, Ohio. 2300 w. Ir Age—Jan. 5, 1905. No. 67006.

Forging.

Forging Machinery. Jas. H. Baker. Considers hammers, forging rolls and presses. General discussion. 8000 w. Pro Engrs Club of W Penn—Dec., 1904. No. 67513 D.

Improved Forging Machinery (Neuere Schmiedemaschinen). P. Möller. Describing small screw forging presses, bolt machines, screw-thread rolling machines, etc., built by Hasenclever, of Düsseldorf. 2500 w. Zeitschr d Ver Deutscher Ing—Jan. 7, 1905. No. 67305 D.

Foundry.

Steel Foundry of the Wellman-Seaver-Morgan Engineering Company, Cleveland, O. Illustrates and describes the equipment of this foundry, which is modern in every respect. 1500 w. Foundry—Jan., 1905. No. 67232.

Gear Cutters.

Wheel Cutting Machines. Thomas R. Shaw. Illustrates and describes wheel-cutting machines of various types, explaining their working. 3300 w. Mech Engr—Dec. 31, 1904. Serial. 1st part. No. 67127 A.

Glass Bearings.

Glass Bearings and Modern Machinery. An illustrated outline of the process of making these bearings for both experimental and practical purposes. 1200 w. Mod Mach—Jan., 1905. No. 67053.

Heavy Work.

Heavy Work of the Port Richmond Iron Works. From a bulletin recently issued by the I. P. Morris Co. An illustrated account of recent engineering construction. Turbines, centrifugal pumps, &c. 1600 w. Mach, N. Y.—Jan., 1905. No. 66987 C.

Lead Pipe.

The Theory and Practice of Compression Machines for Making Lead Pipe (Teoria e Pratica delle Macchine a Compressione per Tubi di Piombo). Ernesto Ascione. A complete study of the flow of metals as applied to the production of lead pipe by forcing the metal through dies. 7 articles. 12000 w. L'Industria—Nov. 13, 20, 27, Dec. 4, 11, 18, 25, 1904. No. 67392 each D.

Melting.

Meting with the Air Furnace. Dr. R. Moldenke. States the advantage to be derived from the use of the air furnace, describing typical designs in use in Europe and in America. Ills. 1800 w. Am Mach—Vol. 28, No. 1. No. 67039.

Molding Machines.

Molding Machines and Their Uses. E. H. Mumford. Read before the A. F. A. Calls attention to some of the simpler machines and their use. 2000 w. Foundry—Jan., 1905. No. 67233.

Molding Machines of To-Day. Herbert M. Ramp. Read before the A. F. A. Discusses the developments in molding machines over those of a decade ago. 1600 w. Foundry—Jan., 1905. No. 67234.

Molding Machine Practice. F. W. Hall. Illustrates and describes the molding of a cone pulley 5 inches in diameter. 2500 w. Foundry—Jan., 1905. No. 67235.

Rolling Mills.

See Mining and Metallurgy, Iron and Steel.

Screw Hoists.

Notes on Cranes—A Screw Hoist. A. D. Williams. Describes screw hoists, giving sketch of screw and driving connections for a 60-ton hoist. 600 w. Am Mach—Vol. 28, No. 1. No. 67038.

Shops.

The New Works of the Fiberloid Company, at Springfield, Mass. Illustrated description of a fireproof plant comprising twenty buildings, equipped with electric drivers, two steam distribution systems, automatic sprinklers on both wet and dry systems, large water filters, incandescent electric lights and up-to-date plumbing. 3000 w. Eng Rec—Jan. 28, 1905. Serial. 1st part. No. 67521.

Messrs. Schneider and Co.s New Electricity Works. Brief description, with illustrations, of the new electric construction works near Fontainebleau. 900 w. Engng—Dec. 31, 1904. No. 67136 A.

See Railway Engineering, Permanent Way and Buildings.

Small Tools.

Care and Control of the Small-Tool Equipment in the Shop. R. Emerson. Discussing systems for the inspection, repair, and maintenance of small-tool kits, with forms from practical service for maintaining control of such supplies issued to workmen. 3500 w. Engineering Magazine—Feb., 1905. No. 67509 B.

Steel Castings.

Defects in Steel Castings (Gussfehler an Stahlgussstucken). Paul Friem. An examination of the causes for the production of cracks, blowholes, and other flaws, and methods for their prevention. 4500 w. Stahl u Eisen—Jan. 1, 1904. No. 67345 D.

Turret Lathes.

Combination Turret Lathe. Illustrated detailed description of a machine used in the manufacture of the various parts of the gear mechanism in motor cars. 1500 w. Engng—Dec. 30, 1904. No. 67140 A.

The Automatic versus the Hand Turret Lathe. Paul Wesley. Gives experience with automatic machines, and describes the method of handling the work on hand and in automatic machines. 1600 w. Am Mach—Vol. 28, No. 4. No. 67474.

MATERIALS OF CONSTRUCTION.

Bower-Barff.

The Inoxidising Furnace (Der Inoxydationsofen). G. Weigelin. Describing the form of regenerative gas furnace used for producing the so-called Bower-Barff coating of rustless magnetic oxide upon articles of iron. 1800 w. Stahl u Eisen—Dec. 15, 1904. No. 67349 D.

Brittleness.

The Brittleness of Certain Steels (Sur la Fragilité de Certains Aciers). MM. A. Perot & H. M. Levy. A note showing the influence of the speed of drop tests upon the indications as to brittleness. 700 w. Comptes Rendus—Dec. 26, 1904. No. 67323 D.

Bronzes.

Physical Characteristics of Certain Bronzes for Steam Use. Strickland L. Kneass. Discusses the essential characteristics of good steam metals, the deteriorating agencies to which they are subject, and the value of the microscope and testing-machine in determining quality. General discussion. 3800 w. Jour Fr Inst —Jan., 1905. No. 67248 D.

Cast Iron.

The Economic Value of Cast Iron. W. H. Pretty. Abstract of a paper read before the Manchester (Eng.) Assn. of Engrs. Considers the most important applications of cast iron, the things that affect the product, the cost, &c. 2200 w. Prac Engr—Dec. 23, 1904. Serial. 1st part. No. 66995 A.

Deformation.

The Behaviour of Materials of Construction without Elastic Limits (Ueber das Verhalten von Konstruktionsmaterialien ohne Proportionsgrenze). Bernh. Kirsch. A review of the experiments of Bach and of Berner showing the nature of yielding beyond the elastic limit. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 16, 1904. No. 67332 D.

Lubricants.

A New Process of Testing Lubricating Oils. Emile Guarini. Illustrated description of an instrument for testing lubricating oils by means of their internal electrical resistance. 900 w. Sci Am Sup—Jan. 14, 1905. No. 67160.

Electrical Investigations of Lubricants (Ueber Elektrische Schmiermitteluntersuchungen). A. Boje. Describing apparatus for measuring frictional resistance, rise of temperature, etc., as applied to lubricants, with tables and diagrams of results. Two articles. 3500 w. Elektrotech u Polytech Rundschau—Dec. 15, 1904, Jan. 15, 1905. No. 67394 each B.

Notes on Safety-Lamp Oils. Dr. G. P. Lishman. Read before the N. of Eng. Inst. of Min. & Mech. Engrs. Considers of what a good safety-lamp oil consists and what it ought to cost. 1200 w. Col Guard—Dec. 30, 1904. No. 67134 A.

Oils for Motor Cars. C. Simmonds. Information concerning the oils in use at the present time as fuels for motors. 2400 w. Nature—Dec. 29, 1904. No. 67118 A.

Steam Cylinder Lubrication. Charles E. Carpenter. A talk on this subject giving general rules and discussing oils and their troubles. 6500 w. Power—Jan., 1905. No. 67023 C.

Testing Cylinder Oils. M. Emile Lecocq, in *Le Journal de Petrole*. Suggests a method of analysis for the examination of lubricating oils. 1800 w. Am Gas Lgt Jour—Jan. 23, 1905. No. 67401.

The Purification of Waste Lubricating Oil. F. H. Davies. Illustrates and describes various types of oil fillers, and other methods of purification. 1800 w. Elec Engr, Lond—Jan. 13, 1905. No. 67442 A.

Testing.

Modes of Testing Castings. W. T. Maccall. Abstract of a paper read before the British Found. Assn. Brief account of tests applied to castings of iron, steel, brass, gun metal, bronze, &c. 1800 w. Mech Engr—Jan. 7, 1905. No. 67192 A.

Punching Considered as a Method of Testing (Le Poinçonnage Envisagé comme Méthode d'Essai). L. Baclé. An examination of the use of measurements of the resistance to punching as an indication of the strength of the material. 3500 w. Bull Soc d'Encour—Nov. 30, 1904. No. 67340 G.

Vanadium Steel.

Researches upon Vanadium Steels (Recherches sur les Aciers au Vanadium). Léon Guillet. A continuation of the author's investigations, with especial reference to the influence of vanadium to steels containing nickel. Serial. Part I. 2000 w. Génie Civil—Jan. 7, 1905. No. 67315 D.

MEASUREMENT.

Blower Tests.

Fan and Positive Pressure Blower Tests. H. E. Field. A report of tests made at Ft. Pitt foundry, Pittsburg. 4000 w. Foundry—Jan., 1905. No. 67238.

Calorimetry.

Calorimetry. John F. Simmance. Shows the value of calorimetry and the method of determining the heating value of gases by the calorimeter, with examples. Ill.

3500 w. Engng—Jan. 13, 1905. No. 67454 A.

Hardness.

Researches on the Comparative Hardness of Acid and Basic Open-Hearth Steel at Various Temperatures, by Means of "Ball-Testing." J. A. Brinell. Brief report of tests, stating results. 600 w. Ir & Steel Mag—Jan., 1905. No. 67255 D.

Hygrometer.

Investigation of Accuracy of a Direct-Reading Hygrometer. R. C. Carpenter. Read before the Am. Soc. of Heat. & Ven. Engrs. Description and investigation of two hygrometers of German make which are said to be within 5 per cent. of correct. Ills. 2500 w. Met Work—Jan. 21, 1905. No. 67273.

Metric System.

The Metric System of Weights and Measures. A. E. Kennelly. Favoring the adoption of the metric system. 4800 w. Pop Sci M—Feb., 1905. No. 67472 C.

Pyrometer.

The Pyrometer in Blast Furnace Practice. S. H. Stupakoff. Read before the Pittsburg Found. Assn. Brief illustrated descriptions of the principal instruments used. 2200 w. Ir Trd Rev—Jan. 5, 1900. No. 67029.

Speed Indicator.

A Centrifugal Speed Indicator (Note sur un Compteur de Vitesse à Force Centrifuge). J. Carlier. A device employing the action of a centrifugal ball-governor to indicate the speed of a machine at any instant. Two articles. 2500 w. Revue Industrielle—Dec. 3, 17, 1904. No. 67393 each D.

Water Meters.

The Measurement of Water (Sui Contatori d'Acqua). Elia Ovazza. A discussion of the principles involved in various forms of water meters, and details of their construction. Three articles. 6000 w. Il Monitore Tecnico—Nov. 10, 20, 30, 1904. No. 67396 each D.

POWER AND TRANSMISSION.

Compressed Air.

Internal Reheating of Compressed Air. C. A. Dawley and A. W. Stone. Discusses methods of reheating, explaining the theory of dry reheating, and of wet heating, and examining some heaters. Ills. 4000 w. Sib Jour of Engng—Jan., 1905. Serial. 1st part. No. 67252 C.

The Compressed Air Power Plants for the Pennsylvania Railroad Tunnels, New York. Brief outline of the plants for the work of constructing tunnels under the North and East Rivers, at New York City. 1000 w. Eng Rec—Jan. 28, 1905. No. 67523.

Three-Stage Air Compressor (Dreistufiger Luftkompressor). Julius Divis. Describing a convenient portable air compressor for mining use. 1800 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen —Dec. 3, 1904. No. 67376 D.

Conveyors.

Coal and Ash Conveying Machinery for Power Plants. Brief illustrated descriptions of many types. 10200 w. Engr, U. S. A.—Jan. 1, 1905. (Special.) No. 67109 D.

The Belt Conveyor as an Elevator. An explanation of the use made of belt conveyors in the Transvaal, giving information in regard to efficiency, horse-power, &c. 2000 w. Engr, Lond—Jan. 13, 1905. No. 67457 A.

The Coal-Handling Plant of the Power-House of the Interborough Rapid Transit Company. Illustrated description of the Robins system, installed to handle coal and ashes at this plant in New York City. 900 w. Elec Rev, N. Y.—Dec. 31, 1904. No. 66982.

Gearing.

Bevel Gear Calculations. J. H. Wright. Describes a method which makes necessary only one reference to a table of tangents. 400 w. Am Mach—Vol. 28, No. 3. No. 67272.

Strength of Gear Teeth. Frank B. Kleinhans. Gives tables calculated by the slide rule, with explanation of their use. 1200 w. Engr, U. S. A.—Jan. 16, 1905. No. 67279 C.

Test of Rough Gray-Iron Spur Gears. W. M. Wilson. An illustrated account of tests made under different conditions of speed and load with the purpose of determining the effect of these different conditions upon the efficiency. 1700 w. Am Mach—Vol. 28, No. 2. No. 67098.

Lubrication.

See Mechanical Engineering, Materials.

Power Plant.

The Mechanical Equipment of the Bellevue-Stratford Hotel, Philadelphia. Begins an illustrated detailed description of a very extensive mechanical plant for hotel service. 3000 w. Eng Rec—Dec. 31, 1904. Serial. 1st part. No. 66960.

See Mechanical Engineering, Hydrau-

The Plant of the Murphy Power Building. Illustrated description of the plant for a Detroit building which furnishes power for all kinds of manufacturing and industrial purposes, an office building, and a central district heating plant. 2500 w. Engr, U. S. A.—Jan. 16, 1905. No. 67278 C.

Speed Gear.

See Mechanical Engineering, Automobiles.

Tidal Power.

Tidal Power Schemes. Gives a résumé of tidal schemes projected or actually carried into practice, with deductions. 2000 w. Engr, Lond—Jan. 13, 1905. Serial. 1st part. No. 67455 A.

Water v. Steam.

Water-Power v. Steam-Power in the British Isles. E. Ristori. Discusses the economical possibilities in Great Britain for the development of hydro-electric plants, comparing with steam plants. 4000 w. Engng—Dec. 23, 1904. No. 67014 A.

STEAM ENGINEERING.

Boilers.

Unequal Temperature Effects in Boilers—Causes of Ripping, Grooving, Pitting, &c. W. H. Booth. Discusses expansion effects discovered in the inspection of boilers. 1200 w. Power—Jan., 1905. No. 67021 C.

Condensing.

Condensing Machinery. William Edward Storey. Read before the Society of Engineers. Illustrates and describes the various types of condensers, tracing the development. 2300 w. Mech Engr—Dec. 24, 1904. Serial. 1st part. No. 67011 A.

Cooling Towers.

Devices for Cooling Condensing Water (Rückkühlwerke). Otto H. Mueller. A description of various forms of cooling towers and other devices for extracting the heat from condensing water in order that it may be used again. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing —Jan. 7, 1905. No. 67304 D.

Engines.

Engines of H. M. S. Black Prince. Illustrated detailed description of the propelling engines, of the inverted-cylinder twin-screw type. 2200 w. Engr, Lond—Dec. 30, 1904. No. 67144 A.

The Machinery of H. M. S. "Argyll." Illustration, with description of the twin engines of this armored cruiser. Also briefly describes the vessel and its equipment, the machinery, &c. 2400 w. Engng —Jan. 13, 1905. No. 67451 A.

Feed Pumps.

Some Notes on High-Speed Feed Pumps and the Reasons of Their Inefficiency. E. C. Barton. Read before the Queensland Inst. Gives calculations made in comparing the relative advantages of a Worthington and a Weir pump. 1700 w. Elec Engr—Jan. 13, 1905. No. 67443 A.

Feed Water.

Boiler Scale and Boiler Feed. Harry Spurrier. A study of water, its solvent action, the effect, &c. 2500 w. Can Engr —Jan., 1905. No. 67150.

Water Softening. G. M. Campbell. Control and results from a chemical standpoint, based largely on experience with the plants on the Pittsburgh and Lake Erie Railroad. 2000 w. Am Engr & R R Jour—Jan., 1905. Serial. 1st part. No. 66993 C.

Fuels.

Fuel Testing. An illustrated description of the plant of the United States Geological Survey at the Louisiana Purchase Exposition. 6600 w. Mines & Min —Jan., 1905. No. 67077 C.

The Economy of Small Size Coal for the Power Plant. Percival Robert Moses. A discussion of the conditions under which buckwheat coal and other low-grade fuels can be advantageously used for steam making. 3500 w. Engineering Magazine—Feb., 1905. No. 67506 B.

The Value of the Flame of Combustibles. P. Mahler. Translated from the *Revue Universelle des Mines.* A comparison of different coals on the basis of the temperature of combustion; also of other combustibles. 2700 w. Jour Fr Inst—Jan., 1905. No. 67245 D.

Lubrication.

See Mechanical Engineering, Materials.

Smoke.

The Smoke Problem (Die Rauchfrage). F. Haier. A discussion of the relation of smoke production to fuel economy, together with the best methods of reducing the evolution of smoke in boiler firing; data from experimental investigations. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 7, 1905. No. 67306 D.

Steam Pipes.

Concerning Pipe Threads. A supplementary article to two others on this subject, giving further facts in relation to pipe threads. Ills. 4000 w. Locomotive —Jan., 1905. No. 67231.

Pipe Joints, Gaskets and Leaks. R. T. Strohm. Suggests a number of ways of securing tight joints. Ills. 2000 w. Am Elect'n—Jan., 1905. No. 67037.

Steam-Pipes. F. H. Davies. Discusses recent practice in steam-pipe work and changes due to increase in steam pressures. 2700 w. Elec Engr, Lond—Dec. 23, 1904. No. 67010 A.

Steam Turbines.

Description of Well-Known Types of Steam Turbines with Special Reference to the Westinghouse-Parsons. R. N. Ehrhart. Considers the different types of turbines now in use, giving illustrations and reports of tests. 4500 w. Pro Engrs Soc of W Penn—Nov., 1904. No. 67242 D.

Efficiency Test of a Direct-Connected Steam Turbine Fan Blower Set. C. R. Waller. Illustrates and describes a test made recently at the testing-room of the De Laval Steam Turbine Co., Trenton, N. J., giving report of tests. 1800 w. Eng News—Jan. 19, 1905. No. 67287.

Practical Data on European Practice with Steam Turbines. Franz Koester. Illustrations of types used, with notes. 1000 w. Eng Rec—Jan. 7, 1905. No. 67067.

The Compound Steam Turbine. Aims to show that if the over-all internal efficiency is known, the frictional loss in each stage can be deduced, and if the total frictional losses per stage are determined, and the bucket speed, the losses can be divided between the guide-blades and the buckets. 5000 w. Engng—Jan. 13, 1905. Serial. 1st part. No. 67447 A.

The Electra Steam Turbine. Walter Rappaport. Brief illustrated description of the method of working. 500 w. Elec Rev, Lond—Jan. 13, 1905. No. 67436 A.

Superheater.

The Schmidt Smoke-Tube Steam Superheater. Illustrates and describes a new form recently brought out. 1100 w. Engng—Dec. 23, 1904. No. 67017 A.

Valves.

The Design of Drop Valves. Concerning the angle of seat employed, with calculations for the correct radii and angles. Ills. 1100 w. Engr, Lond—Jan. 6, 1905. No. 67205 A.

MISCELLANY.

Aeronautics.

The Stability of Dirigible Balloons (Sur la Stabilité des Dirigeables). G. A. Crocco. A mathematical examination of the different conditions of stability of a balloon when at rest and in motion. 800 w. Comptes Rendus—Dec. 26, 1904. No. 67322 D.

Liquid Air.

Commercial Possibilities of Liquid Air. A theoretical consideration of the principles involved and the energyv absorbed by its production and subsequently set free by its volatilization. 2000 w. Engr, Lond—Dec., 23, 1904. No. 67018 A.

MINING AND METALLURGY

COAL AND COKE.

Alabama.

The Pratt Coal Mines in Alabama. W. R. Crane. Information concerning the production of coal in Alabama, its character, quality, etc., with illustrated description of the Pratt mines and methods of mining. 3500 w. Eng & Min Jour—Jan. 26, 1905. No. 67516.

Anthracite.

The Preparation of Anthracite in the Schuylkill Region of Pennsylvania. Illustrates and describes the methods and machinery employed at the Hammond breaker, near Shenandoah. 2000 w. Mines & Min—Jan., 1905. No. 67078 C.

Briquetting.

On Coal Briquetting. Dr. Alfred Gradenwitz. Explains the three types of presses in use, illustrating machines and describing the method of work. 1700 w. Min Rept—Dec. 29, 1904. No. 66976.

Canada.

Canada's Fuel. On the location of the coal fields, character oi the deposits, quantity mined and consumed, etc. 1500 w. Engr, Lond—Jan. 13, 1905. No. 67458 A.

China.

Chinese Coal Developments. Information concerning these extensive deposits, their value and extent, and the development which is to be made possible by the approaching completion of the railway to Taokou. 1600 w. Engng—Dec. 30, 1904. No. 67141 A.

Coal Production.

Coal Mining and Production for the Year 1904. Samuel Sanford. A general review of the year, with statistics of interest. Maps. 4200 w. Min Wld—Jan. 21, 1905 (Special). No. 67411 C.

Coke.

By-Product Foundry Coke. Charles Schwerin. Read before the A. F. A. Remarks on the process of its manufacture and its utilization, particularly for cupola purposes. 2000 w. Foundry—Jan., 1905. No. 67236.

Colorado.

The Coal Fields of Colorado. A. Lakes. The present article gives an illustrated description of the South Platte or northern liquitic coal field, the Louisville coal basin, and the Marshall coal field. 1200 w. Min Rept—Jan. 19, 1905. No. 67415.

Montana.

Coal in Montana. Briefly describes the mines of this region, reporting the development. 2800 w. Min & Sci Pr—Dec. 24, 1904. Serial, 1st part. No. 66975.

Rocky Mountains.

The Rocky Mountain Coal Fields. A. Lakes. An account of these fields, with maps. 1400 w. Min Rept—Jan. 5, 1905. No. 67056.

South Wales.

The Situation and the Outlook in the South Wales Coal Industry. Written under direction of D. A. Thomas. Considers briefly wages, trade, prices, profits, etc. 4000 w. Ir & Coal Trds Rev—Dec. 30, 1904. No. 67145 A.

Storage Plant.

The Largest Coal Storage Plant in the World. An illustrated description of the new plant of the Philadelphia & Reading Coal & Iron Company under construction at Abrams, Pa. It will have a capacity of 500,000 tons. 3000 w. Ir Age—Jan. 5, 1905. No. 67005.

Texas.

The Coal, Lignite and Asphalt Rocks of Texas. Dr. W. B. Phillips. Much information is given concerning these deposits, mining operations, cost of transportation, etc. General discussion. 8000 w. Jour W Soc of Engrs—Dec., 1904. No. 67256 D.

Welsh Coal.

Reserves of Welsh Smokeless Steam Coal for the British Navy. W. H. Renwick. Discusses the schemes for curtailing the export of this coal, with the object of conserving it for future naval requirements. 4500 w. Nineteenth Cent—Jan., 1905. No. 67211 D.

COPPER.

Analysis.

Some Experiences of an Analyst. Dr. J. Ohly. A report of the analysis of some copper ores, showing that the fire assay was very reliable in the three cases investigated. 1500 w. Min Rept—Jan. 5, 1905. No. 67057.

Arizona.

The United Verde Copper Mine. Dwight E. Woodbridge. An illustrated description of this valuable property in Central Arizona. 2000 w. Ir Age—Jan. 12, 1905. No. 67074.

British Columbia.

Copper Mountain, British Columbia. Jules Catherinet. An illustrated article dealing with the genesis of these ores and with their alteration, based chiefly on microscopic study. 2800 w. Eng & Min Jour—Jan. 19, 1905. No. 67275.

Copper.

Copper. Frederick Hobart. Gives an estimate concerning exports and imports, etc. 2300 w. Eng & Min Jour—Jan. 5, 1905. No. 67082.

Copper Trade.

See Industrial Economy.

Cuba.

Copper Mines Near Havana, Cuba. Walter Harvey Weed. Brief description of the Minas district, with illustration. 1500 w. Eng & Min Jour—Jan. 26, 1905. No. 67515.

Lake Superior.

Lake Superior Copper. C. E. L. Thomas. Reports a highly successful year, giving general information. 2500 w. Eng & Min Jour—Jan. 5, 1905. No. 67083.

Queensland.

The Cloncurry Copper Field. Thomas Gibb. A special report on its ores. 4800 w. Queens Gov Min Jour—Nov. 15, 1904. No. 67121 B.

The O. K. Copper Mine. Thomas Gibb. A report of this mine, with illustrations. 2000 w. Queens Gov Min Jour—Nov. 15, 1905. No. 67122 B.

Review.

Annual Review of the Copper Industry for 1904. Horace J. Stevens. Reviews the American production, and the world's production. 6800 w. Min Wld—Jan. 21, 1905 (Special). No. 67413 C.

Eleventh Annual Review of the Lake Superior Copper Industry. Horace J. Stevens. A review of one of the best years ever known as regards production. 1500 w. Min Rept—Jan. 5, 1905. No. 67058.

GOLD AND SILVER.

Alaska.

Alaska. Alfred H. Brooks. A review of the output for the past year, with general information of the mining industry. Map. 2600 w. Eng & Min Jour—Jan. 5, 1905. No. 67085.

Forty Mile, Alaska. J. S. French. An account of mining methods and life in the Yukon basin. Ills. 3700 w. Min & Sci Pr—Dec. 24, 1904. No. 66974.

Alluvial Gold.

The Saving of Alluvial Gold in Alaska and the Klondike. Chester Wells Purington. Notes on sluices and gold-saving appliances from a forthcoming report of the

U. S. Geological Survey. Ills. 2700 w. Min Mag—Jan., 1905. No. 67226 C.

Bolivia.

Mining in Bolivia. D. H. Bradley, Jr. Considers the deposits of silver, gold, copper and tin, the methods of mining, etc. Ills. 1800 w. Min Mag—Jan., 1905. No. 67229 C.

British Columbia.

The Centre Star Mine. L. Heber Cole. Abstract of a paper read before the Min. Sec. of the Canadian Soc. of Civ. Engrs. Illustrates and describes the methods of mining, machinery used, etc., of this mine at Rossland, B. C. The mine consists of iron and copper sulphides. The principal value is in gold carried chiefly by the chalcopyrite. 5000 w. Can Min Rev—Jan., 1905. No. 67514 B.

Cripple Creek.

Report of Progress in the Geological Resurvey of the Cripple Creek District, Colorado. Waldemar Lindgren and Frederick Leslie Ransome. 9000 w. Min Wld —Jan. 14, 1905. No. 67184.

Crushing.

Note on the Influence of Fine Crushing on the Assay Value. A. Whitby. A report of the result of experiments, with short discussion. 1100 w. Jour Chem, Met & Min Soc of S Africa—Oct., 1904. No. 67050 E.

Cyanidation.

Cyanidation in United States. Charles H. Fulton. Reviews the progress, noting experiments made which promise improvements, the increased application, etc. 3700 w. Eng & Min Jour—Jan. 5, 1905. No. 67087.

Deep Leads.

The Deep Leads of Victoria, Australia. Waldemar Lindgren. An illustrated description of the region of its geology and the auriferous character of the leads. 2800 w. Min Mag—Jan., 1905. Serial. 1st part. No. 67228 C.

Dredging.

Gold Dredging and Prospecting. Robert H. Postlethwaite. A short illustrated review of this industry under existing conditions. 4000 w. Min Mag—Jan., 1905. No. 67225 C.

Extraction.

The Use of Electro-Plated Copper Plates in the Battery. F. W. Cindel. Remarks on the system of plates, and the percentage of extraction, with brief discussion. 2300 w. Jour Chem, Met & Min Soc of S Africa—Oct., 1904. No. 67049 E.

French Guiana.

Gold Mining in French Guiana. David E. Headley. An illustrated account of the industry, and of the regulations which allow no one but a surveyor to mark boundaries, and so deprive the poor miner of his opportunity. 1600 w. Eng & Min Jour —Jan. 19, 1905. No. 67277.

Kalgoorlie.

Wet Ball Mills v. Stamper Batteries. A comparison, with special reference to conditions in the Kalgoorlie gold field. Ills. 1400 w. Aust Min Stand—Dec. 15, 1904. No. 67489 B.

Klondike.

The Klondike. J. P. Hutchins. Reports the production as amounting to $1,000,000 less than in 1903, and reviews the work done, the mining methods, etc. 1500 w. Eng & Min Jour—Jan. 5, 1905. No. 67086.

Metallurgical Progress.

Metallurgical Progress in Africa and Australia. Alfred James. Reports concerning the stimulus to regrinding due to H. S. Denny's work, residue treatment, etc. 2800 w. Eng & Min Jour—Jan. 5, 1905. No. 67088.

Mexico.

Mexico. James W. Malcolmson. A review of the districts, showing great prosperity, especially in the production of silver and copper. Map. 3000 w. Eng & Min Jour—Jan. 5, 1905. No. 67089.

Nevada.

Goldfield, Nevada. R. G. Dill. An illustrated report of this district, which has produced $5,000,000 gold during the first twelve months since its discovery. 3200 w. Ores & Metals—Jan. 1, 1905. No. 67024.

Peru.

Gold and Copper Mining in Peru. Enrique Laroza. An illustrated description of the region, its deposits of value, especially gold and copper, the methods of mining, extraction, etc. 3000 w. Min Mag —Jan., 1905. No. 67230 C.

Placers.

The Porcupine Placer District, Alaska. Charles W. Wright. From the U. S. Geol. Survey. An illustrated description of this district in Southeastern Alaska. 2400 w. Min & Sci Pr—Jan. 14, 1905. No. 67298.

Production.

The Production of Gold and Silver in the United States. T. A. Rickard. Statistics and general review of the past year. 1800 w. Eng & Min Jour—Jan. 5, 1905. No. 67080.

The World's Gold Production. T. A. Rickard. Reports an increase in the gold output, reviewing the principal gold-yielding districts. 2300 w. Eng & Min Jour—Jan. 5, 1905. No. 67081.

Silver Ledge.

The Silver Ledge Mill. W. G. Swart. Illustrated detailed description of a mine and mill in Colorado. The ore consists of galena, blende and pyrite, with a little chalcopyrite. 2000 w. Min Rept—Jan. 19, 1905. No. 67414.

Smelting.

The Preparation of Fine Material for Smelting. T. J. Greenway. Describes a briquetting process used at the works of The Broken Hill Proprietary Block 14. 1400 w. Eng & Min Jour—Jan. 12, 1905. No. 67199.

South Africa.

Exhaustion of Outcrop Mines in the Transvaal. J. H. Curle, in *The Economist,* London. Discusses the rapid exhaustion of these mines, claiming that many will not last six years. 1200 w. Eng & Min Jour—Jan. 26, 1905. No. 67517.

Notes on Crushing of Metalliferous Ores in the Stamp Battery in Africa. F. O. Roberts. An account of extraction methods in Africa, and the use of the stamp mill as a crushing machine. 1100 w. Min & Sci Pr—Dec. 24, 1904. Serial. 1st part. No. 66973.

Petrography of Witwatersrand Conglomerates with Special Reference to the Origin of the Gold. Drs. Hatch and Corstorphine. Describes the microscopic characters of sections of banket, and examines the theories presented to explain the presence of gold, favoring the theory of subsequent infiltration. 3000 w. Min Jour —Jan. 7, 1905. No. 67188 A.

Kimberley Notes. T. Lane Carter. Information of interest in regard to conditions at these diamond mines, the growing use of electricity, working costs, etc. 1600 w. Eng & Min Jour—Jan. 19, 1905. No. 67276.

The Transvaal. W. Fischer Wilkinson. Reports the gold production for the year to be about $78,000,000, and gives a review of the important events affecting the mining industry in this field. 1800 w. Eng & Min Jour—Jan. 5, 1905. No. 67090.

Sulphide Ores.

Electricity as an Agent in Treating Sulphide Ores. M. Vaygouny. Describes a series of experiments made by the writer and gives the results. 4300 w. Cal Jour of Tech—Nov., 1904. No. 67213 C.

IRON AND STEEL.

Blast Furnaces.

Stock Distribution in the Blast Furnace. Jos. E. Raysor and John J. Porter. Discusses troubles that arise and their causes, and illustrates some filling devices. 1700 w. Ir Age—Jan. 12, 1905. No. 67076.

The Theory of Carbon-Deposition in the Blast Furnace. A. D. Elbero. An explanation of a new theory. 2000 w. Am Mfr & Ir Wld—Dec. 29, 1904. No. 66957.

Blowing Engines.

Blast-Furnace Vertical Blowing-Engines. Illustrated detailed description of new blowing-engines at the North-Eastern Steel Company's works, England. 1700 w. Engng—Jan. 6, 1905. No. 67203 A.

Cast Iron.

See Mechanical Engineering, Materials.

Dry-Air Blast.

The Drying of Furnace Blast by Refrigeration (Trocknung des Hochofenwindesmittels Kältemaschinen). Dr. C. von Linde. A discussion of the Gayley process for drying the air supplied to blast furnaces, with an estimate of the cost of the operation. 4000 w. Stahl u Eisen—Jan. 1, 1905. No. 67342 D.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Iron Trade.

See Industrial Economy.

Ladle Car.

Twenty-Ton Electric Ladle Car (Elektrisch Betriebener Giesswagen für 20 Tonnen Pfanneninhalt). With photographs showing construction and details for conveying and pouring from the ladle. 1200 w. Stahl u Eisen—Dec. 15, 1904. No. 67348 D.

Lake Superior.

Developments in Lake Superior Iron Mining. Kirby Thomas. A review of the past year, giving chart showing fluctuations in iron and steel prices from 1895 to 1904. 2100 w. Min Wld—Jan. 21, 1905 (Special). No. 67412 C.

The Lake Superior Iron Ranges. Dwight E. Woodbridge. A review of the progress of the Lake Superior ore trade for 1904. 2000 w. Eng & Min Jour—Jan. 5, 1905. No. 67092.

Low Steel.

The Production of Low Steel in the Open Hearth Furnace (Mitteilungen über die Flusseisendarstellung im Siemens-Martinofen). H. Gensmer. A review of recent progress in the production of open-hearth steel, showing the developments of the past ten years. 6000 w. Stahl u Eisen —Dec. 15, 1904. No. 67346 D.

Mesabi.

The Mesabi Iron Ore Range. Dwight E. Woodbridge. Begins a history of this important district. Ills. 2000 w. Eng & Min Jour—Jan. 12, 1905. Serial. 1st part. No. 67200.

Metallurgy.

An Introductory Outline of the Metallurgy of Iron and Steel. Albert Sauveur. From advanced sheets of a work soon to be published. Considers the conditions which must be fulfilled to extract metallic iron from ores, and the chemical and physical principles involved. 4400 w. Ir & Steel Mag—Jan., 1905. No. 67254 D.

Ore Handling.

Improved Handling Machinery (Neue Verladevorrichtungen). H. S. Johannsen. An illustrated description of the improved machinery used in America for excavating and handling iron ore. Serial. Part I. 3500 w. 1 plate. Stahl u Eisen—Jan. 1, 1905. No. 67343 D.

Reheating.

The Garrett Reheating Furnaces. J. S. Trinham. Read before the Staffordshire Ir. & Steel Inst. An illustrated description of this furnace, describing also other types, and explaining its working and advantages. 3800 w. Ir & Coal Trds Rev—Dec. 30, 1904. No. 67148 A.

Rolling Mills.

Plans for Modernizing Antiquated Rolling Mills (Vorschläge zur Modernisierung Veralteter Walzwerksanlage). H. Hübers. With plans of changes and estimates of cost of change compared with economy effected. 2500 w. Stahl u Eisen—Jan. 1, 1905. No. 67344 D.

Rolls for Uneven Angles. William Hirst. Describes the operation of rolling angular sections, illustrating by examples. 3000 w. Ir Age—Jan. 12, 1905. Serial. 1st part. No. 67075.

Wire-Rod and Bar Rolling-Mill Plants. Engravings and particulars of work from a German plant. 1000 w. Engng—Dec. 23, 1904. No. 67501 A.

Roll Turning. W. S. Standiford. Describes the roll lathe and tools for roll turning, roll turners' troubles, etc. 3500 w. Am Mach—Vol. 28, No. 4. No. 67476.

Steel Castings.

See Mechanical Engineering, Machine Works and Foundries.

MINING.

Brazil.

Mining and Hydraulic Engineering in Brazil. William Maude. An illustrated account of the novel conditions under which old placers have been reopened. 4000 w. Engineering Magazine—Feb., 1905. No. 67508 B.

Canada.

A Mining Journey to North-West Canada (Voyage Minier au Nord-Ouest Canadien). J. M. Bel. A very full account of travels in the Canadian Yukon district, with especial reference to mining developments. 12,000 w. 4 plates. Mem Soc Ing Civ de France—Nov., 1904. No. 67359 G.

Crushing.

Crushing with Rolls. R. K. Humphrey. Remarks on methods of crushing, with a discussion of the modern crushing rolls, and their troubles. 2200 w. Eng & Min Jour—Jan. 12, 1905. No. 67201.

Drainage.

German Electrical Installations: Mine Drainage and Ventilation. Emile Guarini. An illustrated article describing the uses to which electricity is applied in the mines. 2500 w. Min Mag—Jan., 1905. No. 67227 C.

Fuse.

Notes on Safety Fuse: Its Manufacture, Testing and Use. James Thomas. A discussion of points named. 5000 w. Jour Chem, Met & Min Soc of S Africa—Nov., 1904. No. 67428 E.

Haulage.

An Approved System of Mine Haulage. Benedict Shubart. An illustrated description of the Morgan third-rail system. 900 w. Min Rept—Jan. 12, 1905. No. 67182.

Ontario.

Ontario. Thomas W. Gibson. Reviews the mining industry for 1904 in this province, where nickel, copper, iron, silver, gold, arsenic, mica, corundum, salt, gypsum and petroleum are among the products. 2200 w. Eng & Min Jour—Jan. 5, 1905. No. 67091.

Power Plant.

The Power Plant of the De Beers Consolidated Mines, Ltd. Alpheus F. Williams. An illustrated description of steam turbines and electrical apparatus at the diamond fields of Kimberley, South Africa, and some of the uses for which the current is utilized. 3600 w. Eng Rec—Jan. 7, 1905. No. 67065.

Quarry.

A Modern Quarry Plant in Mexico. Illustrated description of the equipment of the Hueyapam quarries, and the methods of quarrying. 1200 w. Compressed Air—Jan., 1905. No. 67239.

Refining.

Electrolytic Refining of Lead and the Treatment of Slimes Resulting Therefrom at the Canadian Smelting Works at Trail, British Columbia. Robert L. Whitehead. Ill. 4500 w. Mines & Min—Jan., 1905. No. 67079 C.

Roasting Furnace.

The Holthoff Revolving Hearth Roasting Furnace. Illustrated description. 1200 w. Min Rept—Jan. 12, 1905. No. 67183.

Rock Crushing.

Rock Crushing by Water Power. R. T. Mishler. Describes experiments made with the object of developing a method of calculating the horse power of a water motor, and determining the work required to crush different ores when the crusher is run at different speeds. 1700 w. Cal Jour of Tech—Nov., 1904. No. 67215 C.

Rotary Furnace.

The Rotary Furnace for Roasting Quicksilver Ores. John W. Geary. An illustrated article giving some of the leading features of the process of roasting quicksilver ores as carried out at the Socrates Quicksilver Mine, of California. 1200 w. Cal Jour of Tech—Nov., 1904. No. 67212 C.

Safety Devices.

Improved Safety Devices Against Overwinding (Neue Sicherheitsvorrichtungen gegen das Uebertreiben). H. Jicinsky. Illustrating devices for automatically stopping the engine when the cage reaches the upper safe limit. 3000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Dec. 10, 1904. No. 67377 D.

Sampler.

Improved Sands and Slimes Samplers. Illustrated description of two recently devised appliances. 800 w. Jour Chem, Met & Min Soc of S Africa—Nov., 1904. No. 67429 E.

Shaft Sinking.

Corrugated Tubings for Lining Colliery Shafts. Prof. Heise, in *Gluckauf*. Illustrates form of corrugated tubings, claiming to overcome the defects of previously used linings. 900 w. Ir & Coal Trds Rev —Dec. 30, 1904. No. 67147 A.

Recent Application of the Freezing Process to the Augusta Victoria Mine, Westphalia (Die Neueste Anwendung des Gefrierverfahrens auf der Zeche Auguste Victoria i. W.). H. Joosten. A successful application of the Poetsch freezing process for deepening a shaft through 20 metres of quicksand. Two articles. 2 plates. 8000 w. Gluckauf—Dec. 10, 17, 1904. No. 67374 each B.

Sinking a Shaft by the Freezing Process. From an article by Herr Joosten, in *Gluckauf*. Illustrated description of the work. 3500 w. Ir & Coal Trds Rev—Jan. 13, 1905. No. 67460 A.

Timbering.

Methods of Renewing Old Timbering at the Dives-Pelican Mine, Silver Plume, Colorado. James F. McClelland. Illustrates and describes details of dangerous work, stating the conditions. 2800 w. Sch of Miner Qr—Nov., 1904. No. 67240 D.

Winding Engines.

Coupled Winding-Engine. Illustrated description of Corliss winding engines constructed for the gold mines at Kalgoorlie, Western Australia. 800 w. Engng —Dec. 23, 1904. No. 67016 A.

Electric Winding Engine at Tiremande Colliery. Illustrates and describes an engine recently erected in France designed to raise 105 tons of coal per hour from a depth of 1,412 ft. at a velocity of 26 ft. per second. 1600 w. Ir & Coal Trds Rev—Dec. 30, 1904. No. 67146 A.

The Electric Mine Hoist at the Tolling Shaft at Leoben (Die Elektrische Schachtfördermaschine System Ilgner in Tollinggraben bei Leoben). J. von Lidl. Describing the application of electric power to mine hoisting, handling loads of 800 kilogrammes to a depth of 80 metres at a speed of 2.4 metres per second. 3000 w. 1 plate. Oesterr Zeitschr f Beig u Hüttenwesen—Dec. 3, 1904. No. 67375 D.

MISCELLANY.

Diamonds.

Borts and Carbons, Their Occurrence, Uses, Etc. D. Dessau. An illustrated description of these two minerals, which are pure carbon and entitled to the name of diamonds. 2300 w. Min Wld—Dec. 31, 1904. No. 66977.

Grindstones.

The Production of Grindstones. An illustrated article describing the methods used in the Silverwood quarry, near Sheffield, Eng. 2000 w. Quarry—Jan., 1905. No. 67120 A.

Petroleum Refuse.

The Applications of Petroleum Refuse as Fuel (Masut-Jeuerungen und ihre Anwendung). Ferd. Heck. An account of the methods of burning petroleum residues as a fuel for open-hearth metallurgical furnaces. 2500 w. Stahl u Eisen—Dec. 15, 1904. No. 67347 D.

Pipe Line.

A 100-Mile Oil Pumping Line. A. M. Hunt. A description of a new six-inch line recently put in operation by the Coalinga Oil and Transportation Co., and the method used in trying to predetermine the resistance to pumping. Ills. 2500 w. Jour of Elec—Jan., 1905. No. 67101 C.

Salt.

Salt-Making in the Far West. E. Goldsmith. Describes the method used for procuring salt from the Pacific Ocean or from Great Salt Lake. 2000 w. Jour Fr Inst—Jan., 1905. No. 67246 D.

Tin Plate.

See Industrial Economy.

Wolfram.

Wolfram: How to Know It. B. Dunstan. Notes describing the physical characteristics, properties and other information useful to the prospector. 1500 w. N Z Mines Rec—Nov. 16, 1904. No. 67119 B.

Zinc.

Zinc. W. R. Ingalls. Information concerning the production of the Joplin and other districts. 1200 w. Eng & Min Jour—Jan. 5, 1905. No. 67084.

Notes on the Metallurgy of Sulphur Compounds in the Zinc Retort. Woolsey McA. Johnson. An account by experimental investigation of the action of sulphur in a zinc retort. 2200 w. Elec-Chem & Met Ind—Jan., 1905. No. 67106 C.

Review of the Zinc Industry. Franz Meyer. Information concerning the present state of this industry, considering the ores, roasting, smelting, zinc dust, etc. 3800 w. Elec-Chem & Met Ind—Jan., 1905. No. 67104 C.

The Decomposition and Formation of Zinc Sulphate by Heating and Roasting. H. O. Hoffman. Considers the decomposition by heating in air, and by heating with carbon; and its formation by roasting. Also the formation of zinc ferrate. 12,000 w. Tech Qr—Dec., 1904. No. 67421 E.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

American and British Reports on Railway Accidents. Slason Thompson. A criticism of the reports of the Interstate Commerce Commission, and a comparison with the British reports, and a discussion of other topics bearing upon safe transportation. General discussion. 14400 w. Pro W Ry Club—Dec. 20, 1904. No. 67264 C.

Cheap Service.

On the Question of the Organization of a Cheap Service on a Main Railway's Branch Lines Which Carry Little Traffic and on Light Railways (Subject XIX for Discussion at the Seventh Session of the Railway Congress). J. Rocca. Report No. 1, for all countries, except America, Austria-Hungary, Germany and Holland. 19,000 w. 3 tables and fig. Bul Int Ry Cong—Dec., 1904. No. 67487 E.

Instruction.

A System of Teaching Combustion to Engineers and Firemen. Mr. Buell. Outlines the system taught by the International Correspondence School of Scranton, Pa., explaining how the fuel burns, what the products of combustion are, and how to secure the proper conditions. General discussion. 8500 w. S & S W Ry Club—Nov., 1904. No. 67266 E.

Transportation.

Automobile vs. Railway Transportation. Paul Synnestoedt. Comparison between conditions to be met in railroad service and those which must be considered in automobile transportation. Ills. 6000 w. Pro of Ry Club of Pittsburg—Nov., 1904. No. 67511 C.

MOTIVE POWER AND EQUIPMENT.

Cars.

High-Capacity Cars on the Great Central of England. Illustrates and describes several types of steel cars recently put in service. 1000 w. R R Gaz—Vol. XXXVIII, No. 3. No. 67283.

Car Wheels.

See Mechanical Engineering, Machine Works and Foundries.

Counterbalancing.

Locomotive Counterbalancing. Roger Atkinson. Gives directions for counterbalancing. Ills. 1500 w. Ry & Loc Engng—Jan., 1905. No. 67042 C.

Coupling.

Central Buffer Claw Coupling (Mittelpuffer-Klauenkupplung). A description of the Scheib car coupler, a modified form of the American Master Car Builders' design. 1200 w. Glasers Annalen—Jan. 1, 1905. No. 67328 D.

Cylinder Clearance.

Cylinder Clearance and Valve Events. O. W. Young. Gives diagrams illustrating points the writer desires to make in regard to the importance of reducing back pressure, giving suggestions of value. General discussion. 11,000 w. Pro W Ry Club—Dec. 20, 1904. No. 67265 C.

Electric Locomotives.

See Street and Electric Railways.

Explosion.

Explosion of a Locomotive Engine (Explosion d'une Locomotive). S. Périssé. A full report upon the explosion of a locomotive at the Gare St. Lazare, Paris, July 4, 1904, with data of tests of the material of the exploded boiler. 4000 w. Génie Civil—Dec. 17, 1904. No. 67309 D.

Furnace.

The Langer Smokeless Furnace on the Swiss Locomotives (Le Fumivore Automatique Langer sur les Locomotives Swisses). Emile Bernheim. Describing a combination of steam jet and brick arch, which has been effectively used on the Viège-Zermatt line. 2000 w. Bul Soc d'Encour—Nov. 30, 1904. No. 67341 G.

Locomotive Design.

The Tendencies of British Locomotive Design. J. F. Gairns. Notes the principal features of recent locomotive design in Great Britain, tracing the development. 2000 w. Prac Engr—Dec. 23, 1904. No. 66996 A.

Locomotives.

A French Opinion on American Locomotives. Daniel Bellet. Some information concerning the experiments in France with the American locomotives, and the comparisons made with the French machines. 3000 w. Sci Am Sup—Jan. 14, 1905. No. 67161.

Express Passenger Locomotive for the Great Central Railway. Gives dimensions of six-coupled engines, with their tenders, with illustrations. 800 w. Engng—Dec. 30, 1904. No. 67137 A.

Freight and Passenger Locomotives. An illustrated description of heavy freight locomotives of the 2-8-2 Mikado type, for the Northern Pacific Railway. 800 w. Am Engr & RR Jour—Jan., 1905. No. 66991 C.

Mikado (2-8-2) Locomotive for the Northern Pacific. Illustrated description, with dimensions. 3300 w. R R Gaz—Vol. XXXVIII, No. 3. No. 65280.

On the Question of Locomotives of Great Power (Subject V for Discussion at the Seventh Session of the Railway Congress). E. Sauvage. Report No. 1 for all countries except America. 21,400 w. 14 tables. Bul Int Ry Cong—Dec., 1904. No. 67484 E.

Powerful Prairie Type Locomotives. Shows side elevation, sections, the leading truck, stack, and the arrangement of the front end, with brief description. 500 w. Am Engr & R R Jour—Jan., 1905. No. 66994 C.

The Balanced Compound-Results Obtained from Service. Lanford H. Fry. An illustrated description of this type of locomotive, with illustrations of various machines and report of their working. General discussion. 6000 w. Pro W Ry Club —Dec. 20, 1904. No. 67263 C.

The New Compound Locomotives for the Rhaeticon Railway (Die Neue 4-5 Gekuppelte Verbunde-Lokomotive der Rhätischen Bahn). An illustrated description of a 46-ton two-cylinder compound engine built at the Winterthur works. 1000 w. Schwerz Bauzeitung—Jan. 7, 1905. No. 67339 B.

Petrol.

A Petrol Motor Car for Railways. Illustrates and describes the Dick-Kerr petrol motor car being tried on the Great Northern Railway of England. 900 w. Tram & Ry Wld—Jan. 12, 1905. No. 67446 B.

Petrol Locomotive for Light Railways. Illustrated description of a locomotive built for a 2 ft. 9½ in. gauge. 1200 w. Engng—Jan. 13, 1905. No. 67449 A.

Resistance.

Tractive Resistance of Loaded Railway-Wagons. J. A. F. Aspinall. Paper presented Inst. of Civ. Engrs. (England). An account of experiments made to determine the resistances of 10-ton, 20-ton and 30-ton railway wagons, loaded to their full capacity. Ills. 1100 w. R R Gaz—Vol. XXXVIII, No. 1. No. 67052.

Train Lighting.

See Electrical Engineering, Lighting.

Train Pipes.

The Forsyth Automatic Train Pipe Coupler. J. P. Kelly. Illustrated description of the device and its operation. 500 w. Ry & Loc Engng—Jan., 1905. No. 67043 C.

PERMANENT WAY AND BUILDINGS.

Block System.

On the Question of the Automatic Block System (Subject X for Discussion at the Seventh Session of the Railway Congress). Mr. Margot. Report No. 2 for all countries except America. 10,800 w. 4 tables. Bul Int Ry Cong—Dec., 1904. No. 67483 E.

Theory and Practice of Single-Track Blocking. H. D. Emerson. A discussion of the advantages of the block system, with much related information of interest, and general discussion. 29,700 w. N Y R R Club—Dec. 16, 1904. No. 67268.

Construction.

The Building of the Chicago, Cincinnati & Louisville and Cincinnati, Richmond & Muncie Railroads. H. L. Weber and Fred R. Charles. Illustrates and describes rapid construction, with interesting engineering features. 2000 w. Eng Rec—Jan. 21, 1905. No. 67402.

Foundation-Beds.

Preparing Foundation-Beds for Short Railway Spans. Walter N. Frickstad. Describes the manner in which the foundation-beds for the concrete and masonry on which rest the steel superstructure of some of the bridges recently built by the Southern Pacific in Nevada were prepared, without the use of machinery, except pump and boiler. 4000 w. Cal Jour of Tech—Nov., 1904. No. 67214 C.

Location.

Methods of Location on the Choctaw, Oklahoma & Gulf Railroad. F. Lavis. On the methods of making surveys as practiced on this road, the organization and equipment of parties, etc. 9500 w. Pro Am Soc of Civ Engrs—Dec., 1904. No. 66968 E.

Rail Steel.

The Relative Value of Basic Martin Steel and Thomas Steel for Rails (Empfielt es sich Eisenbahnschienen aus Basischem Martinstahl statt aus Thomasstahl herzustellen). Dr. W. Wedding. A discussion of the value of basic steel rails, advocating the Talbot process. 3500 w. Glasers Annalen—Jan. 1, 1905. No. 67326 D.

Shops.

East Buffalo Locomotive Repair Shop of the Delaware, Lackawanna & Western. Illustrates and describes the rebuilt and enlarged shops at this point, and their equipment. 1200 w. Ry Age—Dec. 30, 1904. No. 66966.

Organization and Operation of a Railroad Blacksmith Shop. A. W. McCaslin. Hints for the foreman and explanation of methods found satisfactory. 1800 w. Am Eng & R R Jour—Jan., 1905. No. 66992 C.

The Steelwork of the Lehigh Valley R. R. Shops at Sayre. An illustrated article dealing with the design and details of the steelwork of these locomotive repair shops. 3400 w. Eng Rec—Jan. 21, 1905. No. 67406.

Signals.

Carbonic Acid Gas for Signals. P. G. Ten Eyck. Explains its use under compression as a power for operating semaphore signals. 1500 w. R R Gaz—Vol. XXXVIII, No. 3. No. 67281.

Interlocking Plants of the Metropolitan Elevated Railway, Chicago. Illustrated description. 800 w. Ry Age—Jan. 13, 1905. No. 67163.

Storage Batteries for Block Signals. E. L. Reynolds. Abstract of a paper read before the Ry. Signal Assn. Reports of companies that have been using storage batteries for signal work, and remarks on the importance of the operating men understanding the best method of operating the cells. 1500 w. R R Gaz—Vol. XXXVIII, No. 2. No. 67164.

Sink-Holes.

Haslett Park Sink-Hole, Grand Trunk Ry. Leslie A. Waterbury, in the *Michigan Engineer*. Describes one of many sink-holes in Michigan which have caused track troubles. Ills. 1500 w. Ry & Engng Rev—Dec. 31, 1904. No. 67025.

Terminals.

Chicago Railway Terminals. Frederic A. Delano. An illustrated article outlining a plan to bring the six different passenger terminals to one point in the city. 2800 w. R R Gaz—Vol. XXXVIII, No. 2. No. 67165.

Proposed Union Station for Buffalo. Extract from a report by W. J. Wilgus. Plan and information of a proposed terminal in which thirteen roads are interested. 1000 w. R R Gaz—Vol. XXXVIII, No. 1. No. 67051.

The Power Plant of a Modern Railroad Terminal. J. R. Bibbins. Illustrated description of an exemplary plant placed in operation at St. Louis embracing a service for electric lighting, electric power, compressed air, steam and water. 5400 w. Eng Rec—Jan. 28, 1905. No. 67519.

The New Grand Central Station. Brief illustrated description of the proposed structure, with editorial. 2400 w. Sci Am —Jan. 21, 1905. No. 67289.

Yards.

Teaming Yards at Railway Stations. H. J. Pfeifer. Read before the St. Louis Ry. Club. Discusses the qualities of a properly constructed yard and its care. 1600 w. Eng News—Jan. 19, 1905. No. 67286.

TRAFFIC.

Rates.

The Regulating of Railroad Rates. Hon. Martin A. Knapp. Outlines the questions involved and the principles to be applied in the regulation of railroad rates by public authority. 3000 w. R R Gaz—Vol. XXXVIII, No. 2. No. 67166.

Review.

Review of Traffic Questions. C. Colson. The railways in 1902 and 1903 in France, England and Germany. 5000 w. 5 tables. Bul Int Ry Cong—Dec., 1904. No. 67488 E.

Suburban Traffic.

On the Question of the Suburban Traffic (Subject XII for Discussion at Seventh Session of the Railway Congress).

H. G. Drury. Report No. 2 for all countries except America. 19,800 w. 9 tables & figure. Bul Int Ry Cong—Dec., 1904. No. 67482 E.

MISCELLANY.

Light Railways.

On the Question of the Direct Financial Co-operation by the State and by Localities Interested in the Development of Light Railways (Subject XVIII for Discussion at the Seventh Session of the Railway Congress). E. A. Ziffer. Report No. 2 for all countries, except Belgium, France, England and Germany. 12,600 w. 1 table. Bul Int Ry Cong—Dec., 1904. No. 67486 E.

Provident Institutions.

On the Question of Provident Institutions (Subject XVI for Discussion at the Seventh Session of the Railway Congress). M. Riebenack. Report No. 1 for countries using the English language. 3500 w. 14 tables. Bul Int Ry Cong—Dec., 1904. No. 67485 E.

Sumatra.

Railways in Southern Sumatra (Spoorwegen in Zuid-Sumatra). J. L. Cluysenaer. With map showing the connections, and some account of the traffic; the entire system includes 1,355 kilometres of track. 7500 w. De Ingenieur—Dec. 17, 1904. No. 67351 D.

STREET AND ELECTRIC RAILWAYS

Acceleration.

The Numerical Computation of the Acceleration Curves for Electric Railways (Rechnerische Bestimmung der Anfahrlinien Elektrischer Vollbahnen). Dr. W. Kummer. A derivation of the mathematical formulas, and their application to concrete examples. 2500 w. Schweiz Bauzeitung—Dec. 17, 1904. No. 67337 B.

Alternating Current.

A Comparison of Alternating Current Railway Systems. J. H. Hallberg. States some of the requirements of electric locomotives for heavy traction, and the four different systems and types of locomotives that have been considered; and describes the Hallberg single-phase to polyphase system, and the Hallberg locomotive. 3800 w. Elec Wld & Engr—Jan. 14, 1905. No. 67187.

Batteries.

On Batteries with Reversible Boosters. C. Turnbull. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Deals with some of the aspects of this solution of a very fluctuating traction load. 4500 w. Elec Engr, Lond—Dec. 23, 1904. No. 67009 A.

Canal Conversion.

The Conversion of English Canals into Electric Railways. F. F. Bennett. Outlines a scheme of amalgamation and electrification, aiming to prove that the change would give profits. 6000 w. Public Works —Jan., 1905. No. 67465 F.

Conflicts.

Street Railway and Highway Conflicts. A review of an interesting paper by Bentley W. Warren, at a Boston meeting of the Good Roads Assn. 6000 w. St Ry Rev—Jan. 15, 1905. No. 67417 C.

Controller.

The Surface Car Controller—Its Performance, Inspection and Efficiency. Edward Taylor. Treats of the type known as the K controllers, discussing explosions, the remedy, effect of operating conditions, &c. 3500 w. St Ry Jour—Jan. 7, 1905. No. 67064 C.

Electric Railways.

The Electric Railway Situation. Dr. Louis Bell. A review of the progress during the past year. 1500 w. Elec Rev, N. Y.—Jan. 14, 1905. No. 67169.

Electrification.

The Application of Electricity to Steam Roads. L. S. Cass. Gives results from practice on 80 miles of track over which are operated electric street cars, electric interurban cars, electric switch engines, and standard and Mogul steam locomotives. Discussion. 3800 w. Pro Iowa Ry Club—Dec. 12, 1904. No. 67267 C.

Gas Power.

The Reconstruction of the Mödling—Hinterbrühl Electric Railway (Die Rekonstruktion der Elektrischen Bahn Mödling—Hinterbrühl). Describing the modernization of the oldest electric railway in Austria, in connection with the introduction of gas engines as prime movers at the power station. Two articles. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 16, 23, 1904. No. 67330 each D.

Heavy Traction.

Discussion on "Problems of Heavy

Electric Traction." Discussions at New York, and at Pittsburg, of the paper by Messrs. Lyford and Smith. 13000 w. Pro Am Inst of Elec Engrs—Jan., 1905. No. 67262 D.

Holland.

The Amsterdam-Haarlem Electric Railway. A full illustrated description of this recently completed line. 7000 w. Elec Engr, Lond—Jan. 6, 1905. No. 67194 A.

The Amsterdam-Haarlem Tramways System. An illustrated detailed description of the construction of this road, and an account of the conditions of franchise, contracts, &c. 5000 w. St Ry Jour—Jan. 7, 1905. No. 67061 C.

The Power Station of the Amsterdam-Haarlem Electric Ry. An illustrated detailed description of the power house at Halfweg. 2200 w. Eng Rec—Jan. 7, 1905. No. 67069.

Hong Kong.

Electric Tramways in Hong Kong. Brief illustrated description of this pioneer system of electric traction in China, with information in regard to the city and surroundings. 2200 w. Elec Engr, Lond—Jan. 13, 1905. No. 67439 A.

Interurban.

Ft. Wayne, Van Wert & Lima Traction Co. Illustrates and describes a recently completed electric railway, as an example of good construction work rapidly executed. 2000 w. St Ry Rev—Jan. 15, 1905. No. 67418 C.

The System of the Stark Electric Railroad Company. An illustrated description of a line in Ohio, built on private right of way. 5000 w. St Ry Jour—Jan. 7, 1905. No. 67060 C.

Legislation.

Electric Tramway Legislation in the Colonies and India. A short summary of the law as now enforced. 4600 w. Elec Rev, Lond—Dec. 30, 1904. No. 67129 A.

Locomotives.

The New Jungfrau Locomotives. C. L. Durand. Illustrated description of the three-phase electric locomotives now used on this road, which are working successfully. 2000 w. Elec Rev, N. Y.—Dec. 31, 1904. No. 66981.

Why Steam Locomotives Must Be Replaced by Electric Locomotives for the Heaviest Freight Service. H. Ward Leonard. Presents facts and arguments tending to show that the electric locomotive will, because of its great economic superiority, replace steam locomotives for the heaviest freight traffic. 4500 w. Elec Wld & Engr—Jan. 7, 1905. No. 67095.

London.

London Electric Railways. Robert P. Porter. Reviews electrical street railway work in London, New York, Paris, Chicago, Berlin, and Boston, especially the underground railways, with conclusions and general discussion. 20000 w. Jour Soc of Arts—Jan. 27, 1905. No. 67670 A.

Mont Blanc.

The Mont Blanc Electric Railway (Die Elektrische Bahn auf dem Mont Blanc). An illustrated account of the proposed electric railway to the summit of Mont Blanc, with profiles and views of the route, and sections of the tunnels. Two articles. 3500 w. Ill Zeitschr f Klein u Strassenbahnen—Nov. 16, Dec. 7, 1904. No. 67389 each D.

Overhead Equipment.

Tramway Overhead Equipment Materials. H. M. Sayers. Read from the Tram. & Light Rys. Assn. Gives a brief analysis of the mechanical and electrical conditions to be satisfied, with reference to the design and erection of the line, materials, &c. 7500 w. Elec Engr, Lond—Jan. 20, 1905. No. 67532 A.

Power House.

A London Electric Railway Power House. Illustrated description of the generating station in Lot's Road, Chelsea. 2800 w. Elec Wld & Engr—Jan. 14, 1905. No. 67185.

Long Island City Power House of the Pennsylvania Railroad. Illustrated description of an installation designed to supply power for the operation of trains through the East River tunnel and for lines now being equipped with electricity by the Long Island Railroad Co. 1800 w. St Ry Jour—Jan. 7, 1905. No. 67062 C.

Steam-Turbine Power Plant of the New York, New Haven & Hartford Railroad at Warren, R. I. Illustrates and describes a plant noteworthy from the directness of the steam lines and the absence of a multiplicity of pipes. 1500 w. St Ry Jour—Jan. 21, 1905. No. 67295 C.

Power Production.

Cost of Electric Railway Power Production and Transmission in the State of Indiana. A. S. Richey. Read before the Indiana Elec. Ry. Assn. Valuable statistics and analysis of costs. 2400 w. St Ry Jour—Jan. 21, 1905. No. 67296 C.

Rail Resistance.

Resistance and Current Flow (Widerstand und Stromverlauf). Dr. Richard Heilbrun. Experimental determinations of the resistance offered by rails and rail bonds to the passage of the return current in tramways. 3000 w. Elektrotech Zeitschr—Dec. 22, 1904. No. 67361 B.

Rail-Welding.

Thermit Rail-Welding at Hartford, Conn. An illustrated account of results secured with the Goldschmidt thermit rail-welding process. 2200 w. St Ry Jour—Jan. 28, 1905. No. 67555 C.

Recorder.

Car-Test Recorder of the Boston Elevated Railway Company. J. M. Ayer and H. S. Knowlton. Illustrates and describes the apparatus for securing automatic test records and its operation. 11000 w. St Ry Jour—Jan. 14, 1905. No. 67167 C.

Roadbed.

Track and Roadbed Construction and Maintenance with Particular Reference to the Life and Chemical Preservation of Ties. Thomas B. McMath. Read before the Indiana Elec. Ry. Assn. Gives information concerning ties treated with creosote and methods of track laying and paving. 1700 w. St Ry Jour—Jan. 21, 1905. No. 67297 C.

San Francisco.

Miscellaneous Equipment of the United Railroads of San Francisco. An illustrated article briefly describing parlor cars, observation cars, funeral cars, electric mail car, cable mail cars, street sweeping cars, oil tank car, trolley tower cars, freight cars, oil-sprinkling car, wrecking cars, sand car, and instruction car. 2500 w. St Ry Rev—Jan. 15, 1905. No. 67416 C.

Shops.

Repair Shop Practice on the Jackson & Battle Creek Third-Rail System. An illustrated description of the repair shop facilities and methods. 4800 w. St Ry Jour—Jan. 7, 1905. No. 67063 C.

Single Phase.

London, Brighton and South Coast Railway and Electric Traction. Gives an account of the circumstances which led to the decision to use overhead conductors fed with single-phase alternating-current at high pressure, with some particulars of the equipment. 3300 w. Elec Rev, Lond—Jan. 20, 1905. No. 67536 A.

Sleet.

Fighting Sleet on the Aurora, Elgin & Chicago Railway. An illustrated article explaining the method of using a solution of calcium chloride. 1100 w. St Ry Jour—Jan. 21, 1905. No. 67294 C.

Sprinkler.

Electric Sprinkler for the City of Cologne (Arroseuse de la Ville de Cologne). B. Géron. Illustrating an electric tram car carrying a water tank and sprinklers for watering the streets. 2000 w. Génie Civil—Jan. 7, 1905. No. 67314 D.

Stray Currents.

See Civil Engineering, Water Supply.

Subway.

The Extension of the New York Rapid Transit Lines. Map, with account of plans outlined in a recent report by William Barclay Parsons for additional lines in Manhattan, Brooklyn, and the Bronx. 2500 w. Eng Rec—Jan. 7, 1905. No. 67071.

The New York Subway (Le Métropolitain "Subway" de New York). Ch. Dantin. A well illustrated account of the underground railway in New York City. Two articles. 6000 w. 2 plates. Génie Civil—Dec. 24, 31, 1904. No. 67310 each D.

Suspension Railway.

New Bogies for the Elberfeld Suspension Railway. An illustrated explanation of an improvement made by introducing a new design of suspending bogie, and the objects fulfilled by the alteration. 1200 w. Engr, Lond—Jan. 13, 1905. No. 67456 A.

Terminal Station.

The New Terminal Station of the Indianapolis Traction Terminal Co. Illustrated description of a fine building in Indianapolis. which compares favorably with the buildings provided by steam railroads. 3000 w. St Ry Rev—Jan. 15, 1905. No. 67419 C.

Tires.

The Steel-Tired Wheel in Street Railway Service. Norman McD. Crawford. Gives facts from the experience of the Hartford Street Railway Company, showing that these wheels are superior not only in safety and serviceability, but also in economy. 2200 w. St Ry Jour—Jan. 21, 1905. No. 67293 C.

Vienna.

Conduits and Conductors of the Electric Tramways of Vienna (Caniveaux el Prises de Courant des Tramways Electriques de Vienne). With sections of the underground conduits, arrangement of feeders, crossings, switches, etc. 1500 w. Génie Civil—Jan. 7, 1905. No. 67317 D.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cts. per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical Industry. *m.* New York.
Electrochemist and Metallurgist. *w.* London.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Public Works. *m.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Electricity.

Experiments with Alternate Currents of High Potential and High Frequency. By Nikola Tesla. Size, 7 in. by 5 in.; pp. ix, 162. Price, $1.00. New York: McGraw Publishing Co.

A reprint, in neat book form, of a lecture originally delivered by Mr. Tesla before the Institution of Electrical Engineers in London, describing the remarkable results attained by the use of his apparatus for demonstrating the effects of high-pressure alternating currents.

The apparatus by means of which the high frequencies are obtained is described in detail, and the remarkable luminous, chemical, and electrical effects are discussed in a manner readily intelligible to an audience. The book is prefaced by a biographical sketch of Mr. Tesla, and has a supplement, giving an account of his experimental laboratory at Colorado Springs, and his tower and laboratory at Wardenclyffe, Long Island.

Reinforced Concrete.

Reinforced Concrete. By Charles F. Marsh. Size, 11 in. by 8 in.; pp. 545. Price, 31s. 6d. ($7.00). London: Archibald Constable & Co. New York: D. Van Nostrand Company.

An exhaustive treatise upon a subject which is at present attracting much attention, both on the Continent and in America, Mr. Marsh's book may be welcomed as giving in one volume a résumé of the most important structures and methods in reinforced concrete.

After a general review of the whole subject the various systems which have been employed since the original work of Monier, this portion being very fully illustrated. A section on materials gives some useful information on the preparation of concrete, while the department on practical construction includes numerous examples chiefly taken from actual structures on the Continent.

The very full section on calculations is preceded by a chapter on experimental research and the data deduced therefrom, this giving the basis upon which computations are necessarily founded. The book concludes with a number of illustrations of engineering structures which have been erected in reinforced concrete, followed by a very complete index.

This is by far the best treatise upon the subject which we have yet seen, and it is certain to be consulted by those who are active in developing this important department in structural engineering, a department, the limitations of which can by no means be seen at the present time. With the increasing scarcity of timber it seems certain that reinforced-concrete piling will replace wooden piles, and it may be that this form of construction will enable the problem of the substitute for wooden railway sleepers to be solved.

While there is no doubt that much of the mathematical and theoretical discussion which is at present being given to the subject of reinforced concrete is of little more than academic interest, it is only by such discussions that the fundamental principles can be definitely settled, and this desirable end will certainly be aided by the collection of the various methods as in Mr. Marsh's book. The volume is especially well printed and fully illustrated.

BOOKS RECEIVED.

Reinforced Concrete. By A. W. Buel and C. S. Hill. New York: The Engineering News Publishing Co.

Steam Turbines, with an Appendix on Gas Turbines and the Future of Heat Engines. By A. Stodola. Translated from the German by Louis C. Loewenstein. New York: D. Van Nostrand Co., London: Archibald Constable and Company.

The Testing of Continuous-Current Machines. By Charles Kinzbrunner. New York: John Wiley & Sons.

Laboratory and Factory Tests in Electrical Engineering. By George F. Sever and Fitzhugh Townsend. New York: D. Van Nostrand Co.

The Mineral Industry. Vol. XII. Edited by D. H. Newland. New York and London: The Engineering and Mining Journal.

Mineral Resources of the United States. Report of the United States Geological Survey. Edited by Dr. David T. Day. Washington: Government Printing Office.

NEWS SUPPLEMENT

The Engineering Magazine—October, 1904

Coming Society Meetings.

American Boiler Manufacturers' Association. Sec.: J. D. Farasey, Cleveland. Next meeting, Oct. 4-6, at St. Louis.

American Gas Light Association. Sec.: A. E. Forstall, 58 William St., New York. Annual convention, Oct. 19-21, at Washington.

American Institute of Architects. Sec.: Glenn Brown, Washington, D. C. Annual convention, Dec. 15-17, at Wash-

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Meetings on fourth Fridays.

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

American Railway Association. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, Oct. 26, at Philadelphia.

American Railway Mechanical and Electrical Association. Sec.: Walter Mower, Detroit. Annual meeting, Oct. 10-15, at St. Louis.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

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American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 6, at New York.

American Society of Municipal Improvements. Sec.: Geo. W. Tillson, Municipal Building, Brooklyn, N. Y. Annual meeting, Oct. 4-6, at St. Louis.

American Street Railway Association. Sec.: T. C. Penington, 2020 State St., Chicago. Annual meeting, Oct. 10-15, at St. Louis.

Association of Railway Superintendents of Bridges and Buildings. Sec.: S. F. Patterson, Concord, N. H. Annual convention, Oct. 18-20, at Chicago.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

Central Railway Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Connecticut State Street Railway Association. Sec.: E. W. Poole, Bridgeport. Annual meeting in November.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block. Convention at St. Louis.

Engineers' Club of Chicago. Sec.: B. W. Thurtell 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: J. F. Wilson, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

Honolulu Engineering Association, Sec.: G. F. Bush, Honolulu, Hawaii.

Indiana Public Utilities Association. Sec.: A. M. Barron, South Bend, Ind. Next meeting, Oct. 18, at Indianapolis.

International Railway Congress. Generan Sec.: Louis Weissenbruch, Belgian State Railways, Brussels, Belgium. Sec. of American Section: W. F. Allen, 24 Park Place, New York. Seventh session, May 3-15, 1905, at Washington.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Iron and Steel Institute. Sec.: B. H. Brough, 28 Victoria St., London, S. W. Annual meeting, Oct. 24-26, at New York.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Massachusetts Street Railway Association. Sec.: Charles S. Clark, 70 Kilby St., Boston. Meetings second Wednesday of each month, except July and August.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New England Street Railway Club. Sec.: J. H. Neal, 101 Milk St., Boston. Meetings on last Thursday of each month.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

New York Street Railway Association. Sec.: W. W. Cole, Elmira. Annual meeting, Oct. 11 and 12, at Utica.

Northwestern Electrical Association. Sec.: Thos. R. Mercein, Milwaukee. Annual convention, Sept., at St. Louis.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Ohio Society of Mechanical Electrical and Steam Engineers. Sec.: Corwin J. Miller, Canton. Next meeting, Nov. 18, at Canton.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: Prof. M. Roberts, Seattle,, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, at Hotel Henry.

Railway Signal Association. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesdays of January, March, May, Sept. and Nov. Annual meeting, Oct. 11, at St. Louis.

Railway Water Supply Association. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

Richmond Railway Club. Sec.: F. O. Robinson, 8th and Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry. New York Section. Sec.: H. Schweitzel, 40 Stone St. Meetings on third Friday after the first Monday of each month, except June, July, August and September, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Technology Club of Syracuse. Sec.: A. Frederic Witmer, 707 Dillaye Building. Meetings monthly, except in June, July, August and September.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Toledo Society of Engineers. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. E. R. Carichoff, Member Am. Inst. of Elect. Engineers, announces that he has opened an office at No. 20 Broad street, New York City, for practice as a general consulting engineer. A specialty will be made of electric elevators and motor control, in the design of which he has had a long experience with the Sprague Electric Co., Otis Elevator Co. and General Electric Co. Also of examinations of inventions and patents.

—Mr. G. E. Bennett has been appointed by the Nernst Lamp Company to act as district sales manager of their Buffalo district office, recently established at 17 West Mohawk Street. These quarters will include an office, show room, exhibition room, and stock room, with a complete stock of lamps, and supplies to meet the requirements of the trade in this territory.

—Mr. Charles S. Miller, of Miller & Franklin, Production engineers, Boston, has recently returned from England, where he spent some time in two large manufacturing plants. He reports that American experience and American ideas are receiving very careful consideration at the hands of British manufacturers at the present time.

Industrial Notes.

—The Technology Club of Syracuse was organized at Syracuse, N. Y., early this year with a charter membership of 129, including engineers, architects, analytical chemists, metallurgists and geologists, the object of the organization being the promotion of professional and social intercourse among the members. The headquarters of the Club are located at No. 707 Dillaye Building, where rooms have been suitably furnished for library and social purposes. Meetings are held monthly, except during the months of June, July, August and September. The annual election of officers takes place at the October meeting. The following officers were elected at the organization meeting: Prof. John E. Sweet, president; Dean William Kent, 1st vice president; Henry C. Allen 2nd vice president; Edward N. Trump, John H. Barr, Edmund L. French, James A. Randall, directors; Alexander T. Brown, treasurer; A. Frederic Witmer, secretary. The club has taken a trip over the Auburn & Syracuse Electric Railway to Auburn, N. Y., where several large manufacturing plants, and the power house of the above mentioned Railway, were visited. These visits to manufacturing plants are to be made one of the special features of entertainment and instruction.

—Forty types of pumping machinery at the St. Louis Exposition are described and illustrated in a handsome pamphlet, 8½ by 12 inches in size, now being distributed by the International Steam Pump Co., of 114 Liberty Street, New York City. Under this heading are included not only the many types of pumps exhibited, but also air-compressing and steam-condensing apparatus, cooling towers, vacuum machines, water meters, etc., etc. The processes in which these machines are employed on the Exposition grounds, such as timber preserving and refrigeration, are fully explained, and diagrams and graphical charts are employed to illustrate the design and arrangement of apparatus. A striking view of the Grand Cascade is shown on the cover and the immense Worthington turbine pumps by which the water is supplied are described in the text. This publication is distributed gratis.

—The American Cement Co. and their agents, Lesley & Trinkle Co., have moved their offices to Rooms 604-610 Pennsylvania Building, 15th and Chestnut Streets, Philadelphia. This change has been made on account of the rapid growth of their business, which made larger offices and increased facilities necessary.

—The Chilian Government has placed a large order for equipment with the Ingersoll-Sergeant Drill Company, including a large Corliss compound compressor and a full complement of Haeseler pneumatic tools for one of its largest ship-yards.

—In connection with the Universal Exposition at Liége, Belgium, in 1905, there will be held, from June 26 to July 1, an international congress of mining, metallurgy, mechanical engineering and applied geology.

This congress is under the patronage of the Belgium government, and is being organized by the "Union des Charbonnages, Mines et Usines Metallurgiques de la Province de Liége" and the association of graduates of the Liége Technical High School. The president of the congress is M. Jules Magery, and the secretary general, M. Henri Dechamps.

—The Brown Corliss Engine Co., of Corliss, Wis., have been awarded a contract for four large vertical cross-compound Corliss engines, to be direct connected to electric generators, for the Washington navy yard.

—The Worcester Pressed Steel Company has been organized at Worcester, Mass., with Milton P. Higgins as president and John W. Higgins as general manager, and will build a large mill near there, equipped with modern machinery for the manufacture of pressed steel articles. The new corporation will also take over the management of the Worcester Ferrule and Manufacturing Company.

—The members of the Associazione Elettrotecnica Italiana, the representative society of electrical engineers in Italy, while passing through New York on their way to the Electrical Congress at St. Louis, paid a visit to the Crocker-Wheeler electrical works at Ampère, N. J., where they had luncheon and inspected the factory.

—Broderick & Bascom Rope Co. are issuing a booklet giving an illustration and a brief description of their striking exhibit at the St. Louis World's Fair, with appreciative comments by some of their visitors.

—The Harrison Safety Boiler Works, of Philadelphia, invite an inspection of their exhibits of Cochrane feed-water heaters, steam separators and oil separators and Sorge-Cochrane systems at the St. Louis Exposition.

—The American Sugar Refining Co., of New Orleans, La., has placed an order for a 16-inch Pittsburgh vacuum exhaust head with the Pittsburgh Gage & Supply Co., of Pittsburgh. This is the fourth repeat order.

—The Electric Controller and Supply Company, of Cleveland, Ohio, have an exhibit in the Palace of Electricity, at the St. Louis World's Fair, the striking feature of which is the direct motor drive for planers. This drive brings the planer to the same high efficiency as the motor-driven lathe. The motor is geared direct to the cross shaft, and instant change and control of speed is obtainable without changing gears or stopping planer. A new system of control especially adapted to mill table motors is shown in operation. This controller makes it impossible to injure the motor by "plugging," and will be of interest to all engineers and mill men. Several distinct lines of crane controllers are shown. These controllers are specially designed to withstand the rough handling usually the lot of such apparatus in mills and factories. They are all built with the resistance self-contained. All parts are easy of access for inspection, and wearing parts are made renewable, thus cutting the repair expense to a minimum. A line of knife switches, cast grid resistance banks, solenoids, magnetic friction and stop brakes and crane fittings are also shown and a working exhibit of the Clark lifting magnet. This magnet is suspended to a Brown Hoisting Machinery Co. tramway hoist and will be of special interest to those who have billets, slabs or plates to handle. The exhibit is in charge of an experienced electrical engineer, who will be pleased to give information to those interested.

—Warren Webster & Co. will install the Webster system of steam heating in the new department stores of John Wanamaker in Philadelphia and New York. This system has been in use for a number of years at the old Wanamaker store in Philadelphia, where it has given such satisfaction that it was adopted for the immense new stores.

—The World's Fair Street Railway Commission, which is making exhaustive electrical tests at the Bullock Electric Mfg. Company's exhibit at Section 15, Palace of Electricity, St. Louis Exposition, under the direction of Profs. Norris of Cornell, Swenson of Wisconsin and Plum of Perduex, got some interesting results last week while testing the temperature co-efficients of steel rails. These tests are made by taking the resistance of the rail at a normal temperature, then passing a large current through the rail to raise its temperature through a range of 30 degrees centigrade, and at various stages of heat making other tests. The results so far have been rather surprising. There seems to be but little difference in the resistances at the various temperatures.

It has been suggested that this may be due to the presence at the same time of iron and carbon in the steel, the one losing in conductivity while the other gains with the rise of temperature. So far the drop in voltage has been found to be much smaller with direct than with alternating current, and it varies much with the variations of current density and saturation. The relationship has not been established. Tests for this purpose will now be made with constant wave forms, those heretofore used having varied some in this respect.

—The Curtis & Co. Manufacturing Company have an interesting exhibit at the St. Louis World's Fair, in Machinery Hall, some of the features of which are as follows: A steam feed mill in actual operation, temporarily driven by compressed air supplied from motor driven air compressors, a small variable-friction feed mill and many other kinds of saw-mill machinery. Among the pneumatic machinery, besides the air compressors, are shown three Curtis pneumatic traveling cranes in operation, varying in capacity from 800 to 20,000 pounds, a freight elevator with direct hoist of 2500 pounds capacity, and a variety of other lifts and hoists. These machines have many distinctive and valuable features, and the whole exhibit is a very instructive one.

—The U. S. Wind Engine and Pump Co., of Batavia, Ill., have acquired all the patent rights of the Tweeddale Water Softening Co. and taken over their entire business, which will henceforth be conducted by the first-named company.

—The Aultman & Taylor Machinery Co., of Mansfield, Ohio, the manufacturers of the Cahall water-tube boilers, have an exhibit at the St. Louis World's Fair, which includes eight 508 horse-power horizontal boilers, built to carry 250 pounds steam pressure, four 508 horse-power horizontal boilers, for 175 pounds pressure, eight 400 horse-power horizontal boilers, also for 175 pounds pressure, and three 250 horse-power vertical boilers. All of these Cahall boilers have Aultman & Taylor chain-grate stokers, and each installation of horizontal boilers is equipped with an independent induced draft apparatus, and the coal is fed to the stoker hoppers by storage tanks and the conveyor system. Each vertical boiler has an independent stack and is operated with natural draft. The high-pressure boilers are used for operating the steam turbines that are located in the Palace of Machinery, and the other boilers supply steam for engines. All the boilers and stokers are located in the central portion of the Steam, Gas and Fuels Building, which is directly west of the Palace of Machinery. In addition to this working exhibit, the Aultman & Taylor Machinery Co. have a very large non-working exhibit situated in the northwest corner of the Palace of Machinery. This exhibit consists of one 125 horse-power horizontal water-tube boiler, equipped with the Aultman & Taylor Machinery Co.'s superheater and chain-grate stoker, and the boiler is bricked up on one side, leaving the other side exposed, so that the entire system can be examined. There is also one cross-drum type horizontal water-tube boiler of 100 horse-power capacity, bricked up entirely on one side, and one 100 horse-power vertical water-tube boiler, bricked up in similar manner. This exhibition is an extremely interesting one, as it permits of a thorough study of the different types, in which the travel of the gases can be easily followed. In addition to these three full-sized boilers, all of the parts are shown in unassembled condition.

—At the present time much interest centers in the steam turbine, which promises to reduce the weight and cost of prime movers. Two large machines of this type are on exhibition in block 51, aisle 1, and block 44, aisle 10, Machinery Building, at the St. Louis Fair, one being shown by the Westinghouse Machine Company and the other by the General Electric Company. Econimic utilization of the energy of steam requires its expansion to the lowest possible pressure, which in the turbine is accomplished without the usual losses due to the correspondingly low temperatures. In actual service the economy of the turbine is increased by approximately 3 to 5 per cent. for each inch of vacuum higher than 26 inches. It is therefore of vital importance that all losses should be reduced to a minimum. The absence of oil from the steam renders the use of a surface condenser desirable in places where the saving of condensed steam is important. The fact that the final temperature of the condensing water must be comparatively low necessitates the highest degree of efficiency in its use and the immediate and complete removal of all non-condensible vapors, whose presence would increase the absolute pressure and consequently reduce the efficiency of the turbine. The steam from the Westinghouse-Parsons turbines at block 51 is condensed in a 1,500-square-foot surface condenser, supplied by Henry R. Worthington. The air is removed by a Worthington rotative dry vacuum pump of the center-crank type, but similar in other respects to the horizontal pumps already described. An air cooler is interposed between the condenser and the vacuum pump, considerably increasing the capacity and efficiency of the latter. The condensed steam is removed from the condenser, by a Worthington volute pump directly connected to an induction motor. The operation of this pump is very interesting, since it requires neither valves nor floats and is not subject to vapor binding, as are reciprocating pumps. The pump is placed below the level of the condencer, receiving the water by gravity and its capacity is such that it runs ahead of the supply, so that the suction pipe is never full. The discharge pipe is, however, always full and pressing back against the pump, but so long as the latter is in motion there is no possibility of the water passing back to the condenser, so no automatic devices are needed. In another turbine plant a pump of this character returns the hot water directly from the surface condenser to the boiler against a pressure of 250 pounds. The Curtis steam turbine, exhibited by the General Electric Company in block 44, is of the vertical type, and the condenser is placed in the base of the steam turbine. It contains 8,000 square feet of tube surface and was built by Henry R. Worthington. The air is removed by a rotative dry vacuum pump, similar as regards the air end to those heretofore described, but driven through the medium of a silent chain by an electric motor.

The working model concentrating plant built by the Allis-Chalmers Co., which forms one of the most interesting features of the State of Utah exhibit in the Mines and Metallurgy Building, at the St. Louis Fair, is to be presented to the Utah School of Mines after the close of the Exposition. Every separate part of the plant has been lettered with descriptive legends, so that the onlooker, as he watches the plant at work, will be able not only to see what is being done but will also be able to learn the name of the part that does the work. This makes the plant much more interesting as an exhibit and will add greatly to its value as an adjunct to the Utah School of Mines.

—The Northern Pacific Railway has issued a book entitled "Wonderland, 1904," descriptive of the territory traversed by this road, which is full of beautiful illustrations, and has sections devoted to the Yellowstone Park, the Haunts of Wild Game, the Lignite Coal Area in North Dakota, Irrigation in the Northwest, the Travels of Lewis and Clark, and other subjects. This railroad also issues a pamphlet on the Yellowstone National Park, with maps and illustrations, showing how to get there and what to see there. These publications are supplied for six cents and two cents, respectively, by the Passenger Department of the Northern Pacific Railway, St. Paul, Minn.

—An extensive and comprehensive exhibit of mine models, maps, photographs, literature of mining, metallurgy, etc, is being made in the Mines and Metallurgy Palace, at the Louisiana Purchase Exposition, St. Louis. Included in this display are the following: Maps, charts, photographs and models illustrating geologic or topographic features, and their relation to mineral deposits, or the structure or mode of occurrence of mineral deposits. Mine models, working plans of mines; maps, photographs, etc., of mining operations, plants, camps, etc. Statistics and publications relative to geology, mineralogy, palaeontology, topography, quarrying, mining, metallurgy, and the manipulation of mineral products, the development of water resources, etc.

—Josephus Plenty, of Jersey City, has recently closed contracts for skylight work, as follows: International Steam Pump Works, Harrison, N. J., Bert L. Baldwin, engineer, 93,000 square feet; Lehigh Valley R. R. shops, Sayre, Pa., Walter G. Berg, chief engineer, 75,000 square feet; National Tube Co., Lorain, Ohio, E. D. Mower, superintendent of construction, 40,000 square feet; Central R. R. of New Jersey train shed, Jersey City, N. J., 12,000 square feet; League Island Navy Yard, Philadelphia, Pa., 6,000 square feet.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Centrifugal Pumps.

Bulletin No. 9, containing a report by Professors J. E. Denton and William Kent on tests of De Laval centrifugal pumps, two driven by De Laval steam turbines and one by an electric motor, with illustrations, curves and tables. 9 by 6 in.; pp. 24. De Laval Steam Turbine Co., Trenton, N. J., and 74 Cortlandt St., New York.

Circuit Breakers.

Catalogue No. 19043, containing illustrations and descriptions of automatic circuit breakers in different styles and for various uses with both alternating and direct current. 10½ by 7½ in.; pp. 14. Also, circulars Nos. 19046 and 19047, devoted, respectively, to ceiling and fan controllers and to a "variable speed motor" controlling panel which fulfills U. S. Government specifications. Ward Leonard Electric Co., Bronxville, N. Y.

Electric Apparatus.

Bulletins Nos. 4381 and 4382, containing, respectively, illustrations and descriptions of small-plant alternating-current switchboards for 1150 and 2300 volts and of Thomson inclined-coil portable indicating instruments. 10½ by 8 in.; pp. 4 and 8. Also, flyers devoted to enclosed fuse cut-outs, small direct-current generators, direct-current ceiling fan motors, and ready-made electric-lighting outfits for decorative lighting. General Electric Co., Schenectady, N. Y.

Electric Driving.

Bulletin No. 218, devoted to the industrial application of Sprague electric motors for direct-current circuits, with many illustrations showing these motors as geared, belted and direct connected to machine tools, pumps, printing presses, looms, blowers, hoists, winches and other machines. 10½ by 8 in.; pp. 32. Sprague Electric Company, 527-531 West 34th St., New York.

Booklet No. 41, containing illustrations and descriptions of "Northern" electric motors and other apparatus on exhibition at the St. Louis World's Fair, in the Electricity Building and elsewhere, the motors driving machinery of every variety. Also, map of the Fair grounds. 6 by 3½ in.; pp. 16. Northern Electrical Mfg. Co., Madison, Wis.

Electric Hoists.

Catalogue No. 046, containing illustrations and descriptions of electric hoists, winches and capstans in various styles, for direct or alternating currents. 9¼ by 6¾ in.; pp. 20. C. W. Hunt Company, West New Brighton, Staten Island, N. Y.

"Four Powers."

"The Book of the Four Powers," a handsome pamphlet briefly setting forth the scope of the Allis-Chalmers manufactures, including steam engines, water turbines and other hydraulic machinery, gas engines, electric generators and motors, mining machinery, saw mills, and other products, illustrated with artistic half-tones, and with a tastefully designed cover. 10½ by 8 in.; pp. 46. Allis-Chalmers Company, Chicago.

Gas Engines.

Pamphlet, containing illustrations and description of the Sargent complete-expansion gas engine, which possesses many features of special merit, with an account of its method of operation and indicator diagrams. The engines are furnished in units of from 100-horse power up, in single-cylinder-tandem and twin-tandem styles, and for all purposes. 9 by 6 in.; pp. 16. The Wellman-Seaver-Morgan Co., Cleveland, O.

Gasoline Engines.

Catalogue No. 14, containing illustrations and description of high grade gas and gasoline engines adapted to all power purposes, portable gasoline engines on steel and on wooden trucks, a portable electric power plant operated by a gasoline engine, patent revolving wipe contact electric igniter, geared governor, and other details and accessories, views of the Foos shops, useful data, telegraph code and index. 8 by 10½ in.; pp. 39. Also, circular No. 65, showing, in convenient form, the many points of advantage found in the Foos engines. 9 by 6 in.; pp. 4. The Foos Gas Engine Co., Springfield, O.

Gas Producers.

Catalogue, containing illustrations and description of the Morgan continuous gas producer, equipped with the George automatic feed for distributing the coal evenly, uniformly and continuously over the whole surface of the fire. The producers supply gas fuel for iron and steel industries, glass manufacture, ore roasting, brick burning, lime burning, annealing, chemical manufacturing, and any operations involving heating. 9 by 6 in.; pp. 14. Morgan Construction Co., Worcester, Mass.

"St. Louis Exposition Edition" of catalogue containing illustrations and descriptions of producer-gas power plants of the pressure and the suction types, and on the Mond system, with or without by-product recovery. 11 by 8½ in.; pp. 12. R. D. Wood & Co., Philadelphia.

Handling Machinery.

Large book, bound in flexible cloth, with handsome half-tone illustrations on heavy paper and descriptions of the McMyler machinery for the rapid loading and unloading of cars and vessels, including machines for dumping cars bodily, revolving cranes, trolley direct unloaders and bridge tramways, buckets, and other kinds of hoisting and conveying machinery. 11½ by 9 in.; pp. 55. The Dodge Coal Storage Company, Nicetown, Philadelphia.

Inspection Car.

Catalogue No. 112, containing illustrations and specifications of the Oldsmobile railroad inspection car, with gasoline engine, and testimonials from railroad men who have used it. 9 by 6 in.; pp. 8. Railway Appliances Co., Old Colony Building, Chicago.

Inspirator.

Pamphlet, containing illustrations, description and price list of parts of the Hancock inspirator, type E, universally interchangeable, for feeding locomotive boilers with diagrams showing limiting temperatures and capacities of feed water. 12 by 9 in.; pp. 6. The Hancock Inspirator Company, 85 to 89 Liberty St., New York.

Locomotives.

"Record of Recent Construction," No. 48, containing handsome illustrations and descriptions in English and French of various types of locomotives built for United States and foreign railroad companies and industrial establishments, and the U. S. Government ordnance proving grounds at Sandy Hook. 6 by 9 in.; pp. 32. Baldwin Locomotive Works, Philadelphia.

Machine Tools.

Catalogue, containing illustrations and descriptions of hollow hexagon turret lathes and screw machines, universal turret lathes, valve milling machines, automatic boring and tapping machine, key lathes, cutting-off machine, vertical turrêt machine, horizontal boring machine, and other high-grade machine tools and appliances for working iron and brass. 9 by 6 in.; pp. 59. The Warner & Swasey Co., Cleveland, O.

Nozzle.

Pamphlet containing a reprint of a thesis by H. C. Crowell and G. C. D. Lenth, of the Civil Engineering Department of the Massachusetts Institute of Technology, on "An Investigation of the Doble Needle Regulating Nozzle," showing the distribution of the velocity and the high efficiency of the jet from this nozzle, with illustrations, diagrams and tables. 9 by 6 in.; pp. 30. Abner Doble Company, San Francisco.

Pneumatic Tubes.

Pamphlet, containing a reprint of an article in *Compressed Air,* by Edmond A. Fordyce, describing and illustrating the very complete and efficient pneumatic-tube system installed at the New York Stock Exchange by the Lamson Consolidated Store Service Company. 9 by 6 in.; pp. 7. Also, folder with illustrations of pneumatic tube systems and electric, spring and gravity cash and parcel carriers. 9 by 4½ in.; pp. 11. Lamson Consolidated Store Service Co., Boston.

Pumping Engines.

Bulletin L 601, containing illustrations and comprehensive descriptions of Meyer-gear pumping engines and their details for small waterworks and elevator service. These engines are built in the cross-compound and three-cylinder-compound types, and with fork frames or rolling-mill frames, and possess many advantages. 9 by 6 in.; pp. 20. Laidlaw-Dunn-Gordon Co., 114 Liberty St., New York.

Refrigerating Machinery.

Catalogue, containing descriptions and illustrations of small ammonia compressors and other apparatus for use in small cold storage plants, with approximate cost of operation and other useful information. 6 by 9 in.; pp. 29. United Iron Works Co., Springfield, Mo.

Shapers.

Catalogue B, containing half-tone illustrations and descriptions of the most modern styles of shaping machines, both belt and motor driven, and of their parts and attachments; together with telegraph code. 9 by 6 in.; pp. 36. Gould & Eberhardt, Newark, N. J.

Steam Engineering School.

Pamphlet with illustrations and descriptions of the State Steam Engineering School, conducted by James Coyne, M.E., whose specialty is the preparation of engineers and firemen for examination for licenses. 5 by 7 in.; pp. 20. State Steam Engineering School, Boston, Mass.

Steam-Pipe Covering.

Pamphlet containing a reprint of a paper by H. G. Stott before the Association of Edison Illuminating Companies, on "Steam-Pipe Covering and its Relation to Station Economy," giving an account of tests made for the Manhattan Railway Co.'s great power house in New York, as a result of which Carey's 85 per cent. carbonate of magnesia coverings were installed. 9 by 6 in.; pp. 12, diagrams, 4. Philip Carey Mfg. Co., Lockland, Station R, Cincinnati.

Thermit.

Pamphlets containing illustrated instructions for welding iron and steel pipes, shafts, girders and other parts and shapes by means of the Goldschmidt thermit process, in which intense heat is generated by the combustion of a mixture of powdered aluminum and other substances. Also, price lists. 9 by 5½ in.; pp. 12 and 8. Goldschmidt Thermit Co., 43 Exchange Place, New York.

Time Stamp.

Folders with illustrations and descriptions of time stamps which are portable, automatic, self-inking, compact, simple and practical, and which record the hour and minute as well as the date. 6 by 3½ in.; pp. 6. Perry Time Stamp Company, 72 S. Canal St., Chicago.

Valves.

Pamphlet containing illustrations and descriptions of the Forster patent water-sealed reversing valve for regenerative gas furnaces, open-hearth furnaces, crucible furnaces, soaking pits, and so on, with list of users. 9 by 6 in.; pp. 12. The Wellman-Seaver-Morgan Company, Cleveland, O.

Water-Wheel Governors.

Bulletin No. 5, illustrating and describing the Sturgess self-contained water-wheel governors, in which the governor and the pump are both mounted upon the same base, the latter being a hollow cylinder containing the oil under pressure which operates the governor. 9 by 6 in.; pp. 4. Sturgess Governor Engineering Co., Watervliet, N. Y.

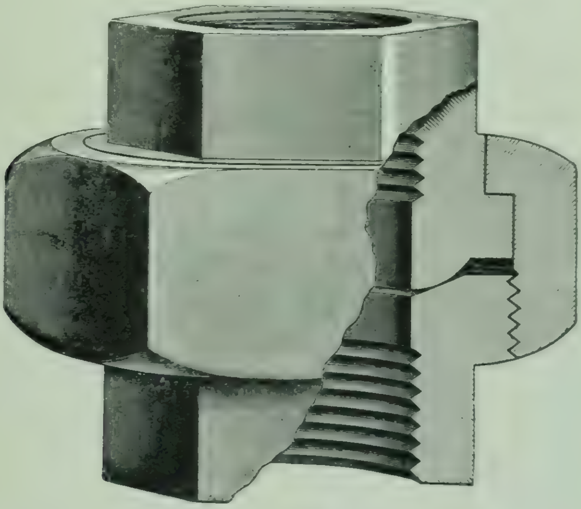
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Tuxeda Union.

AS steam pressures and temperatures go up, it becomes more and more necessary to guard against leakage, and the problem of securing tight joints gets to be a difficult one to solve. The union connecting the ends of pipes is often a weak point in a plant, and may cause a great deal of annoyance and trouble, so that it pays to have one that can be absolutely depended upon.



THE TUXEDA UNION.

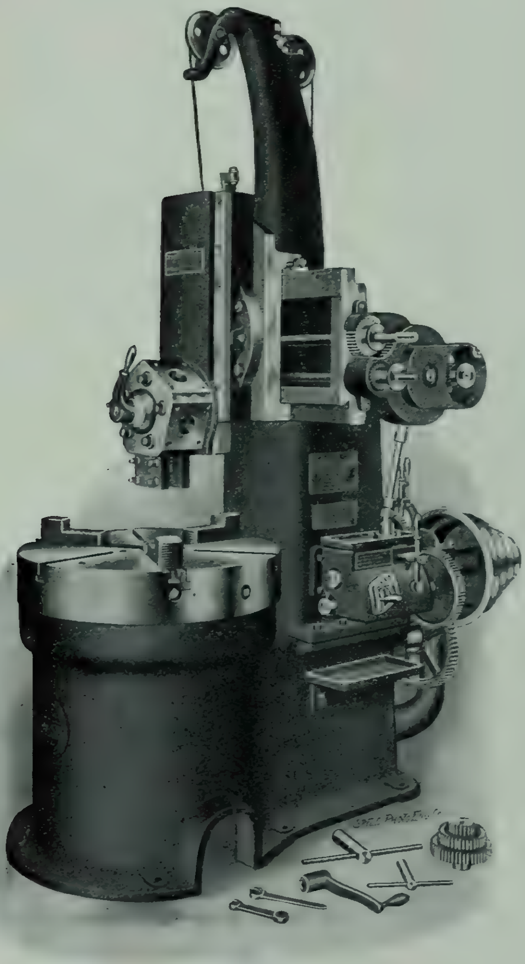
Such a reliable union is the "Tuxeda," which has been especially designed to meet the requirements of high-pressure steam plants, both afloat and ashore. It is made of Tuxeda bronze, a special alloy which possesses unusual soundness and high tensile strength, and is made in a way which shows a full appreciation of the exacting requirements of high pressures, superheating and continuous service.

The ends are extremely heavy, thus preventing any spreading, and are hexagonal in shape, so that they can be conveniently and quickly manipulated by any smooth-faced wrench, without danger of having the edges worn down by the slipping of a monkey wrench, or marred by the jaws of a Stillson, as would be the case with round-end patterns.

The joint is made by a slightly tapered seat, to which is fitted a nose that is rounded and well ground, so that a positive surface of contact is always assured, even if the pipes are out of alignment. This self-seating feature of the union prevents any trouble arising from unequal expansions and deflections of pipes.

These unions are made in sizes up to four inches and will stand the severest usage, and on account of their long and accurately cut threads, and their general strength and solidity, they can be changed about and used over and over again without destroying their effectiveness.

They are now being specified by some of the leading engineering firms, who realize that with up-to-date plants it will not do to leave the selection of a union to a contractor who will be guided by cheapness rather than by efficiency. Some of the great electrical power plants which have recently been erected are equipped with these unions, which are also largely used in marine work, where they give great satisfaction.



BAUSH BORING AND TURNING MILL.

The Tuxeda unions are especially well adapted for drip piping and oiling systems, for use with superheated steam and for withstanding the actions of acids in smelting and mining plants.

Further information will be gladly furnished by the manufacturer, Franklin Williams, of 39 Cortlandt Street, New York.

Boring and Turning Mill, with Swivel Turret Head.

AMONG the most recent products of the general advance movement in machine-tool design and construction is the 30-inch boring and turning mill shown in the accompanying illustration.

This mill has a swivel turret head, and is furnished with a three-jaw independent and universal chuck combined, but can be fitted with a plain table, with or without jaws. The mill swings 32 inches in diameter, and 15½ inches under the cross rail, while the diameter of the chuck is 30 inches.

The chuck or face plate has eight changes of speed, from 73 revolutions per minute to 18 revolutions per minute, without back gears, and from 9.3 revolutions per minute to 2.28 revolutions per minute with back gears, and its height above floor is 2 feet 9⅜ inches.

The chuck is bolted to a large driving gear which has an outer bearing, with automatic oiling device arranged in bed so as to keep the outer bearing continually well lubricated. The center spindle, which is 7 inches in diameter and 18 inches long, is made with an angular bearing to receive the side strains, with check nuts on the under side of the spindle to act as a precaution against any lifting tendency.

The turret slide has a traverse of 16 inches, and in the swivel head can be set over at any angle up to 30 degrees, and will face 30 inches in diameter.

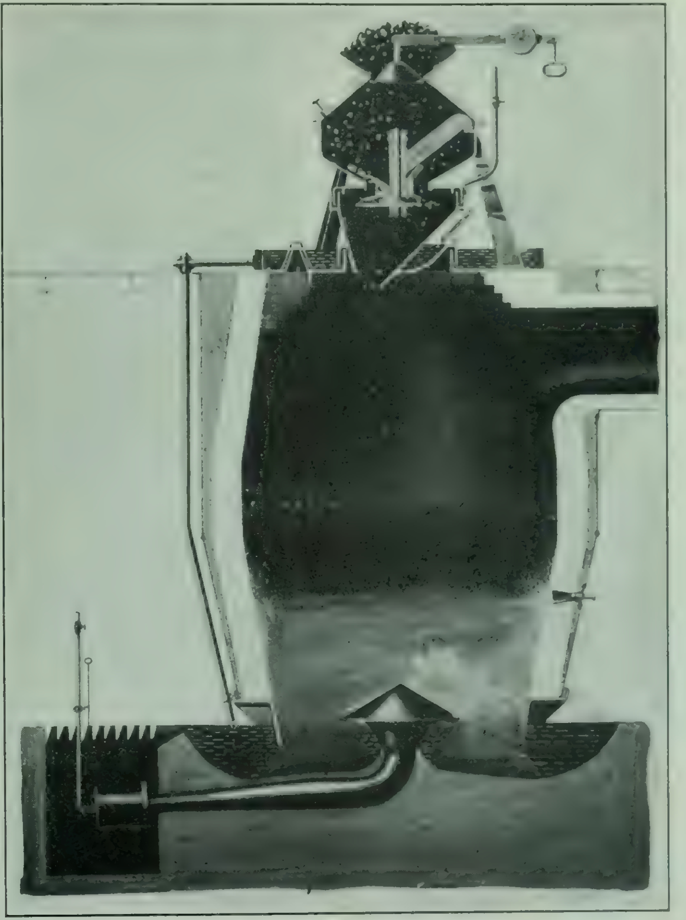
The mill has arranged on its upright the Hendey-Norton change gear device for feeding and thread cutting, and it will cut the following threads: 6, 7, 8, 9, 10, 12, 14, 16, 18 and 20 threads to the inch.

The vertical feeds have twenty changes, from .0125 to .1666 per revolution of the table and the horizontal feeds have also twenty changes, from .015 to .211 per revolution of the table.

The mill is driven by a cone of large diameter, having a 3-inch belt, and is so arranged that it can be made with a motor drive at any time. The back gears can be changed by means of a lever, without the use of a lock-nut. The turret has five sides, 10 inches across the flats, and has five 2 3/16-inch holes, unless otherwise specified. The countershaft has a 4-grade cone with tight and loose pulleys, which should be driven at 200 revolutions per minute.

The machine is self-contained and therefore does not require an expensive foundation. It occupies a floor space 6 feet, 9 inches by 4 feet. Its net weight is 5,900 pounds and its shipping weight, including countershaft and wrenches, is 6,400 pounds, crated.

Further information will be gladly furnished by the manufacturers, the Baush Machine Tool Co., of Springfield, Mass.



THE MORGAN GAS PRODUCER.

Continuous Automatically-Fed Gas Producers.

ONE of the latest developments in the line of fuel economy is shown in the accompanying illustration. The great natural gas supplies have been both instructive and elusive. They have taught us the great benefits of gas firing over coal firing, but now that we have learned the lesson, nature's ideal fuel is rapidly disappearing and something has to take its place.

It is not generally known, but is nevertheless a fact, that practically all of the benefits of gas firing, even including the low cost, can be and are secured by the use of the simple modern gas producer, which, fed by almost any grade of coal, converts practically the whole of its heat energy into gas, and when properly applied is as useful and economical a servant as natural gas, and far more reliable.

In a good steam blown gas producer *automatically fed,* as made by the Morgan Construction Company, the gas is of uniform quality practically every minute of the day, and with an *average* quality of bituminous coal shows the following analysis:

Carbon Monoxide (CO)	23 to 25	per	cent.
Hydrogen (H)	19 to 17	"	"
Hydrocarbons $\left\{\begin{matrix} C_2H_4 \\ CH_4 \end{matrix}\right\}$	6	"	"
Carbon Dioxide (CO_2).	4	"	"
Nitrogen (N)..........	48	"	"
	100	"	"

Such a gas as it leaves the producer will carry (including its sensible heat) about 180 heat units per cubic foot, and there will be from 65 to 75 cubic feet for every pound of coal, depending on the quality of the coal.

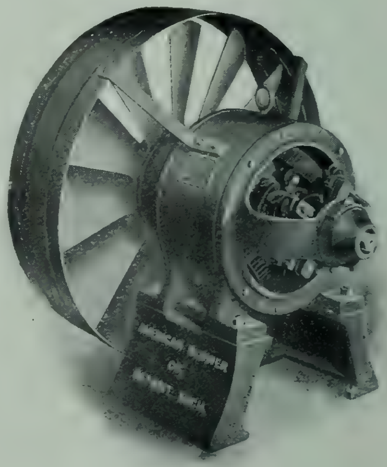
When properly applied this gas will effect any metallurgical or other melting operation requiring the highest temperatures just as perfectly and economically as annealing or heating operations at lower temperatures.

Anthracite is equally available for gas-making by this process and even its cheapest forms (buckwheat and rice sizes) work with remarkable ease and a very small amount of labor. The gas from this fuel, however, is not as rich as from average bituminous coal.

Much depends upon the way in which the gas is applied, but of first importance is the construction of the generator itself, which from being merely a closed fire-box twenty years ago, is now developed into a machine having the machine-like attributes of continuity, uniformity, reliability and economy.

The operation of plants of this character is just as simple and requires no more skill than the firing of a steam boiler. There are thousands of manufacturers in scores of different lines who are using many hundreds and often many thousands of tons of coal per annum in direct furnace firing, and paying twice as much as they should be paying for their fuel and the labor to handle it.

Such manufacturers and all others who are interested in this problem are invited to correspond with the Morgan Construction Company, 40 Exchange Place, New York City, who will gladly send an illustrated pamphlet and furnish information regarding such installations.



Disc Fan and Electric Motor.

ONE of the latest forms of the American Blower Co.'s disc fans, direct connected to a Westinghouse electric motor, is shown in the accompanying illustration.

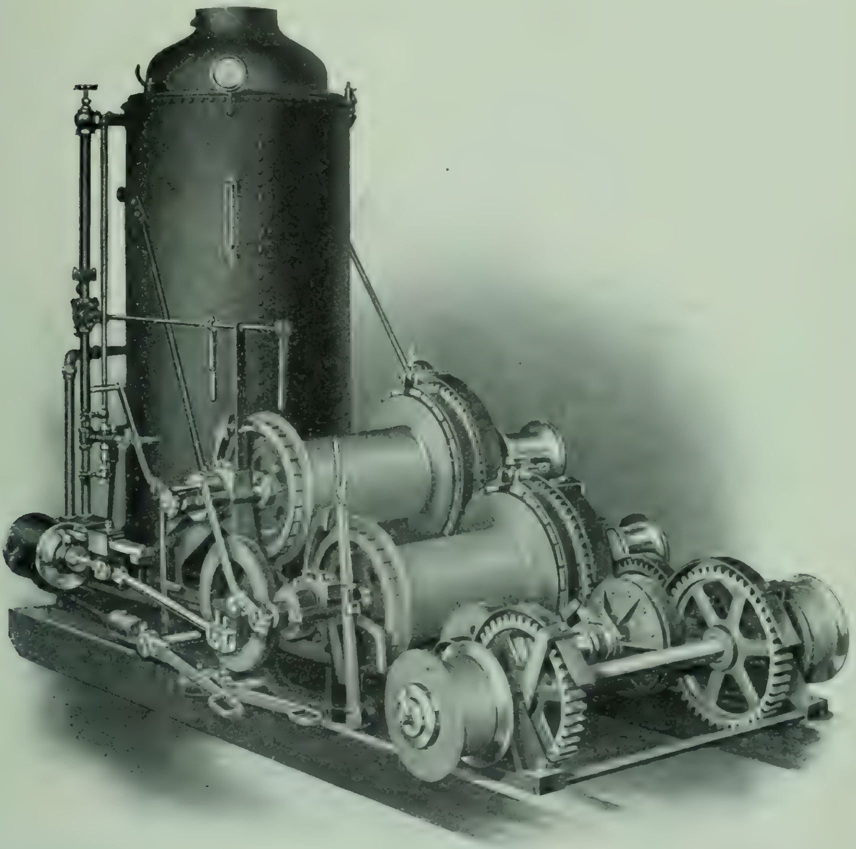
Slight modifications have been made in the regular "A B C" fan, and the motor, instead of being attached to the arms of the fan, as has heretofore been customary, is placed upon a substantial base, resulting in a combination of exceptional rigidity and compactness.

Before shipment the motor is run under load and tested for temperature, commutation and regulation, each and every part having previously been submitted to a thorough and rigid system of tests and inspection while under construction. The series wound multipolar form is used, except for the very small machines, which are made bipolar.

Free ventilation is made possible by the general design, insuring cool running under heavy load, long life and low cost of maintenance. The bearings are self-oiling and run for weeks without renewal of the lubricant. The machine requires a minimum of care and attention during operation.

The open type of motor shown in the illustration is usually furnished. Enclosed motors may, however, be obtained at a slight additional cost where conditions require their use. Each motor is furnished with an automatic release switch and a fireproof rheostat with marble front and carefully finished and fitted working parts.

Further information concerning these outfits may be obtained by addressing the American Blower Company, Detroit.



Boom Swinging Gear for Lidgerwood Hoisting Engines.

THE Lidgerwood Manufacturing Company have already put upon the market three different types of boom swinging gear for derrick engines, each of which has demonstrated its superiority over the one which preceded it, and in the swinging gear herewith illustrated they have devised still another which, it is expected, will prove the best and most popular apparatus of the kind yet invented.

This apparatus is employed for swinging the boom of any ordinary derrick while at the same time the boom is being raised and the load hoisted, and it consists of a drum shaft, with two gear wheels and two drums, and a friction shaft and two frictions, and pinions mounted on side stands tied together by two flat steel braces, secured to the bottom of the side stands and countersunk in them, making an independent apparatus which is mounted on an extension of the engine skids, and fastened to the front ends of the engine bed-plate. If desired the engine bed-plate may be extended and the swinging gear mounted on it.

The friction shaft is driven by a pinion, next to the winch head on the forward drum shaft, meshing with an idler gear which in turn drives a gear wheel keyed fast to the outer end of the friction shaft. There are two cone frictions on the friction shaft, the male part, carrying the friction woods, being mounted on the shaft with a feather key, and the female part being cast with a pinion and mounted loosely on the shaft. The pinion of one drives a gear directly on the drum shaft, thus turning the drums in one direction while the pinion of the other drives an idler pinion, which in turn drives the other gear on the drum shaft, turning the drums in the other direction. The drums are spirally grooved and the ropes wind over on one drum and under on the other.

Thus when the female friction is moved into contact with one flange the rope is wound up on one drum and unwound, on the other drum, and when the other friction is in contact the same thing occurs, but in a reverse direction. The ropes being attached to the bull-wheel of the derrick it is thus swung in either direction.

The frictions are applied by means of nuts, traveling on composition sleeves having screw threads which are mounted on the friction shaft and attached by suitable connections to an auxiliary shaft carrying the vertical operating lever. When this lever is in a central (or vertical) position neither friction is engaged, but when it is moved forward it causes one nut to travel on its screw and pushes one friction cone into engagement, and at the same time the other nut releases the other friction cone. When the lever is moved back the reverse takes place. One lever therefore controls the swinging of the boom in a manner that is simple and effective.

The friction cones are of a special patented type and of great holding power. The frictions can readily be replaced when worn without impairing the main parts of the apparatus.

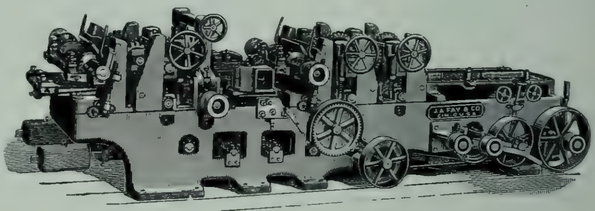
One of the swinging drums is keyed fast to the shaft, and the other is loose thereon but prevented from turning by means of a collar keyed to the shaft, on which are lugs or projections which fit into corresponding recesses in the drum. When the collar is loosened and moved back the drum may be revolved far enough to take up the slack due to the stretching of the rope, and then the collar moved back into place and secured.

The drums being outside the bearings, the ropes leading to the bull-wheel are not in the way of the hoisting and boom lines. The whole mechanism is positive, strong, and well made in every detail and adapted for the most severe service.

This swinging gear is made on the duplicate part system and all parts are easy to get at. It occupies a small amount of space, does not add much to the weight of the engine, can be operated easily and quickly. The apparatus can be placed upon any of the Lidgerwood standard double-drum hoisting engines, either with or without a boiler, which is an important feature.

The boom swinging gear is one of the most valuable improvements that has ever been placed upon a hoisting engine, as it not only largely increases the capacity of a derrick, but saves the expense of swinging the boom by hand, a laborious, slow and expensive method of doing the work.

Further information will be gladly supplied by the Lidgerwood Manufacturing Co., of 96 Liberty St., New York.



New Triple-Cylinder Floorer.

ALL persons engaged in wood-working will be interested in the new and improved flooring machine, shown in the accompanying illustration, as in certain work a flooring machine is indispensable. It has been patented, and is designed for those who make flooring, ceiling, siding, casing, etc., in large quantities. A consideration of some of its points will prove interesting.

It planes four sides 9 and 14 inches wide, and up to 6 inches thick, and by the use of an endless belt apparatus, 1½-inch stock can be matched to advantage, this last device being a new feature. The massive frame prevents vibration and resists all strain, and the machine can be run at a very high rate of speed if desired, while under the absolute control of the operator.

The feed is six large powerfully driven rolls, having expansive gearing, and which can easily be raised and lowered. The feeding-out one is provided with scrapers, and the rate of feed can be furnished as desired.

The improved matcher works are very heavy and powerful in all parts; the three cylinders are four sided and slotted and furnished with chip-breaking lips to work cross-grained or knotty lumber, while the shaving hoods swing outward to give access to the knives. The pressure bars have easy and quick adjustments, and possess many improved points to facilitate their operation.

The lower cylinder is vertically adjustable at each end, and the second upper cylinder is at the feeding-out end of the machine, being designed to give a light skimming cut. It revolves at a much higher rate of speed than the other cylinders, and fine smooth work is insured, with all wear compensated by the cylinder-raising screws.

Further details, with cuts fully describing this machine, and other information, including their new catalogue, will be sent to those interested by the makers, J. A. Fay & Egan Co., of No. 212 to No. 232 West Front St., Cincinnati, Ohio.

HEAVY COMPOUND LOCOMOTIVE.

Heavy Articulated Compound Locomotive.

THE large pushing locomotive just turned out of the Schenectady shops of the American Locomotive Company for the Baltimore & Ohio Railroad is by far the heaviest and most powerful locomotive in the world, the total weight being 47,000 pounds greater than any other locomotive ever built, and the weight on drivers 100,000 pounds greater. In other words, the adhesive weight, and, therefore, the tractive power of the Baltimore & Ohio locomotive is equal to what would be obtained by adding a fifty-ton locomotive to the heaviest one already built. It should be stated in this connection that a fifty-ton locomotive was one of the heaviest in use ten years ago.

This locomotive has twelve driving wheels to distribute the immense weight, involving a total wheel base of 30 feet, 8 inches. In order to secure freedom in curving, and avoid damage to tracks, the front section of these driving wheels form part of a flexible truck, which can follow the curvature of the tracks freely. This practically reduces the rigid wheel base of the locomotive to 10 feet, which is the extreme distance between the driving wheels of each set. This principle of articulated or flexible locomotive is the design of Mr. A. Mallet, of Paris, France, and a large number of locomotives, built according to this principle, are in use in all parts of Europe.

The locomotive built by the American Locomotive Company, however, is nearly twice as large as any other locomotive of this type which has ever been built, and in fact is far heavier than any other steam locomotive in the world.

The locomotive is built on the compound system, the high-pressure cylinders being connected with the back set of driving wheels with rigid steam pipe to the boiler, which has a steam pressure of 235 pounds. The steam is exhausted from these cylinders through a flexible receiver pipe to the low-pressure cylinders, which are carried by the forward truck, and, of course, move with this truck. The flexible receiver pipe is, of course, only subjected to the receiver steam pressure, or about 60 pounds, making it very easy to keep tight. A separate exhause valve is provided in connection with the high pressure cylinders, which is identical in design with that used with the Richmond system of two-cylinder compound locomotives. This valve permits the engine to be operated as a single locomotive, in starting, or upon very heavy grades, thus permitting an additional power of, perhaps, 20 per cent.

The use of the compound system, while essential in this type of locomotive in reducing the pressure upon the flexible joints, is also of great advantage in economy of fuel, and the trials made of this locomotive on the New York Central grade at Schenectady show extremely satisfactory results in economical coal consumption in view of the immense tractive power obtained.

The valve gear is known as the Walschaert type, and is very largely used in Europe. Its advantage in this engine, over the ordinary locomotive, is the fact that its parts are outside of the driving wheels, where they can be readily inspected and oiled, leaving the space between the frames available for the flexible receiver pipe and other parts.

The engine is reversed and the cut-off regulated by a compressed-air reversing apparatus, designed by Mr. Carl J. Mellin, who was the engineer in charge of the design of this locomotive. This power-reversing gear has worked very satisfactorily, and it will be of great help in reducing the work required by a locomotive engineer in handling this immensely powerful machine.

The tender, and a large part of the details of the locomotive, are Baltimore & Ohio standard, and the engine will be used on the B. & O. for pushing service on their heavy grades.

The locomotive has been designed with great care, with a view to maximum durability, and freedom from breakdowns, and it is noteworthy that the locomotive was finished complete without a hitch or interference of any part with another, the design working out exactly as planned in every respect. The weight distribution especially is exceedingly satisfactory, there being a difference of only 900 pounds between the weights on the back and front sets of driving wheels, and considering the fact that no locomotive of any such size has ever before been built, and that the design was practically new throughout, this statement shows the great accuracy of the calculation made.

Notwithstanding the immense weight and power of this locomotive, the fact that the driving wheels and cylinders are divided into two sets, enables the parts to be made of ample strength, and yet with reasonable weight, the connecting rods, crossheads, and all parts of the valve gear being considerably lighter than those used on many of the heavy locomotives of the ordinary type.

In case the machinery in connection with one set of driving wheels becomes disabled, the locomotive could be run at one-half its power with the remaining set, and the change in this respect could be accomplished with very little difficulty, and by a locomotive engineer on the road.

Further information regarding this locomotive will be gladly supplied by the American Locomotive Company, of 25 Broad St., New York.

Motor-Driven Buffing Lathes and Dry Grinders.

IN order to supply the demand for effective electric motor-driven buffing lathes and dry grinders a line of these machines has been placed on the market by the Bridgeport Safety Emery Wheel Company and the Crocker-Wheeler Company. It is a complete line of motor-driven tools of this class of extremely neat and effective construction. Instead of extending an ordinary motor spindle and making a base to fit the motor, the emery-wheel builder supplies shafts upon which the Crocker-Wheeler Company mount their armatures. The shaft is larger and stronger than necessary for an ordinary motor shaft and is supported by unusually long bearings to secure rigidity against the vibration to which these tools are subject. The design of the motor is slightly modified to make the two a harmonious unit in every particular.

Machines of this class must of course be

NEWS SUPPLEMENT

The Engineering Magazine—November, 1904

Coming Society Meetings.

American Institute of Architects. Sec.: Glenn Brown, Washington, D. C. Annual convention, Dec. 15-17, at Washington.

American Institute of Electrical Engineers. Sec.: Ralph W. Pope, 95 Liberty St., New York. Meetings on fourth Friday of each month at Carnegie Hall, 154 W. 57th St., New York. Subject for Nov. 26: "Heavy Electric Traction."

American Institute, Polytechnic Section. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

American Society of Civil Engineers. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month.

American Society of Mechanical Engineers. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 6, at New York.

Boston Society of Civil Engineers. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

Brooklyn Engineers' Club. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

Canadian Railway Club. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

Canadian Society of Civil Engineers. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

Central Railway Club. Sec.: Harry D. Vought,, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

Chicago Electrical Association. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

Civil Engineers' Club of Cleveland. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

Civil Engineers' Society of St. Paul. Sec.: G. S. Edmondstone. Regular meetings on second Monday of each month.

Connecticut State Street Railway Association. Sec.: E. W. Poole, Bridgeport. Annual meeting in November.

Engine Builders' Association of the United States. Sec.: D. Fleming, Harrisburg, Pa. Annual meeting, Dec. 2 and 3, at New York.

Engineering Association of the South. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

Engineers' Club of Chicago. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

Engineers' Club of Cincinnati. Sec.: C. H. Meeds, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

Engineers' Club of Columbus (Ohio). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

Engineers' Club of Minneapolis. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

Engineers' Club of Philadelphia. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

Engineers' Club of St. Louis.. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

Engineers' Society of Western New York. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

Engineers' Society of Western Pennsylvania. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

Franklin Institute. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

Honolulu Engineering Association. Sec.: G. F. Bush, Honolulu, Hawaii.

Indiana Public Utilities Association. Sec.: A. M. Barron, South Bend, Ind. Next meeting, Oct. 18, at Minneapolis.

International Railway Congress. General Sec.: Louis Weissenbruch, Belgian State Railways, Brussels, Belgium. Sec. of American Section: W. F. Allen, 24 Park Place, New York. Seventh session, May 3-15, 1905, at Washington.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Massachusetts Street Railway Association. Sec.: Charles S. Clark, 70 Kilby St., Boston. Meetings second Wednesday of each month, except July and August.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, at Pierce Hall, Copley Square.

New England Street Railway Club. Sec.: J. H. Neal, 101 Milk St., Boston. Meetings on last Thursday of each month.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Ohio Society of Mechanical Electrical and Steam Engineers. Sec.: Corwin J. Miller, Canton. Next meeting, Nov. 18, at Canton.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J. D. Conway, P. & L. E. R. R. Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signal Association. Sec.: B. B. Adams, 83 Fulton St., New York. Regular meetings on second Tuesday of January, March, May, Sept. and Nov.

Railway Water Supply Association. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter at Alexander Hall, South Minneapolis, Minn.

Richmond Railway Club. Sec.: F. O. Robinson, 8th and Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry. New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, except June, July, August and September, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of Jan., April, Aug. and Nov., at Atlanta.

Technical Society of the Pacific Coast.. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Technology Club of Syracuse. Sec.: A. Frederic Witmer, 707 Dillaye Building. Meetings monthly, except in June, July, August and September.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Toledo Society of Engineers. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

Western Railway Club. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Hermann Nieter, of 180 Broadway, New York, is the representative of the Hammond Iron Works, of Warren, Pa.

—Mr. William A. Doble, president of the Abner Doble Company, San Francisco, is a member of the International Jury of Awards, in the Department of Machinery, at the Louisiana Purchase Exposition, St. Louis.

—Dr. Hermann von Schrenk, who is in charge of the Division of Forest Products, of the Bureau of Forestry, and of the Mississippi Valley Laboratory at St. Louis, has written a number of pamphlets on the diseases of timber and their prevention, on timber preservation and on railroad ties and rail fastenings, all of which are issued by the U. S. Department of Agriculture.

—Mr. G. Fred Collins, who has a very extensive acquaintance throughout the East among officials and engineers of large railroad and steel companies, has recently entered the employ of the Allis-Chalmers Company as special representative at their New York office.

—Mr. D. M. Duller, of 202 Moore Burnett Building, Houston, Texas, has become chief engineer of the American Rice Cereal Co., of Kansas City, Mo., which owns eight irrigation canal systems in Louisiana and Texas.

—Mr. R. C. Routledge, formerly of Messrs. Thomas Smith & Co., of New York, has taken charge of the contract department of the H. W. Johns-Manville Co., of 100 William St., New York, to which he will give his undivided attention.

—Mr. Spencer Miller, chief engineer of the Lidgerwood Mfg. Co., of New York, has returned from St. Petersburg, where he went by request of the Russian Government to inspect ten Lidgerwood marine cableways which they had installed upon the ten largest battleships and cruisers of the Baltic Fleet, known, however, in Russia as the Second Pacific Squadron, and the sailing of which has been a matter of much discussion in the daily press for months past.

—Messrs. Erskine Ramsay and Charles E. Bowron, who have both had many years' experience as engineers and managers of mining and metallurgical plants in the Birmingham, Ala., district, have formed the firm of Ramsay and Bowron, at 2024½ First Ave., Birmingham, Ala., for general engineering practice, making a specialty of examinations and reports of Southern plants and properties, and of plans and estimates for mining plants, coke ovens and similar works.

Industrial Notes.

—The Association of Licensed Automobile Manufacturers have issued a Hand-Book of Gasoline Automobiles, for the information of the public who are interested in the manufacture and use of these vehicles, and primarily for the convenience of the prospective purchaser of an automobile. The machines of the principal American manufacturers and of the importers of the leading foreign gasoline automobiles are shown in handsome half-tone illustrations, accompanied by specifications. These specifications include the principal features of the machine and are printed in black and red, in uniform style, so that the characteristics of the different automobiles can be very easily compared, the prices being also given. The automobiles shown include all varieties, from the racing machine and the heavy, elaborately fitted touring car, to delivery wagons, runabouts and buckboards. The hand-book is most tastefully and attractively gotten up, and will appeal to everyone interested in automobiles. It may be obtained by sending six cents in postage stamps to the Association of Licensed Automobile Manufacturers, 7 East 42d St., New York.

—The Reeves Engine Company have received an order from Messrs. S. Pearson & Sons, Inc., for six vertical cross-compound engines, which are to supply the light and power for the Pennsylvania Railroad Co.'s East River tunnel. Three of them will be installed on the New York side, and three on the Long Island side. The Reeves Engine Company have also received orders for seven vertical cross-compounds for the Columbus (Ohio) sewage disposal plant, and for three engines of the same type from The William Tod Company, of Youngstown, Ohio, for the Youngstown sewage disposal plant, all of these engines being for direct connection to centrifugal pumps.

—Keuffel & Esser Co., of 127 Fulton St., New York, have a very large, complete and interesting exhibit at the St. Louis Exposition of the products of their factories, which are the largest of their kind in America and perhaps the largest in the world. The exhibit consists of surveying instruments of all kinds, drafting instruments, devices for mathematical calculations, furniture for the drafting room, blueprinting material and apparatus, including frames for printing by electric light, nautical instruments, such as binnacles, sextants, compasses, etc., instruments for forest surveying and other forestry work (a new industry in this country), measuring tapes in great variety, and a number of very interesting special instruments for military purposes, such as Keuffel & Esser Co. furnish to the U. S. Army and Navy. The articles are displayed in and about an ornamental pavilion near the center of the Palace of Liberal Arts, the nautical instruments being placed on an imitation ship with a pilot house. The exhibit occupies over 1,500 square feet of floor space and is both artistically and systematically arranged, the apparatus being grouped in an orderly manner which facilitates inspection and study.

—The E. M. Dart Manufacturing Co., of Providence, R. I., report that the year just past has been the most prosperous one in their history, and that they have considerably increased the output of their patent union couplings, which the year before was about 500,000.

—Mr. D. O. James, who was a member of the firm of James & Foote, manufacturers of cut gears, whose plant was damaged by fire last June, has sold his interest in the tools and machinery saved from the conflagration to Mr. Foote, and has started a new business on his own account. Mr. James is now located at 35 and 37 South Canal St., Chicago, where he has a modern shop equipped with the latest and most improved machinery for making spur gears, bevel gears with planed teeth, internal gears, spiral gears and worm gears.

—The Reeves Engine Co., of 85 Liberty St., New York, closed orders for thirty-six of their engines during September. Recent tests of a Reeves engine, made by Professors R. C. Carpenter and H. Diederichs, at Sibley College, Cornell University, gave very interesting and satisfactory results.

—The Ball Engine Co., of Erie, Pa., are in receipt of an order for two 1,000-horsepower horizontal cross-compound Corliss engines, direct connected to alternators, for the People's Ice, Light & Storage Co., of McKeesport, Pa., and have also recently received many other orders for their engines from all parts of the country.

—The Stirling Company, of Chicago, the manufacturers of water-tube safety boilers, have appointed Mr. Frederick A. Scheffler special representative, with headquarters at their New York office in the Engineering Building, 114 Liberty St., New York. Mr. Scheffler will be associated with Mr. A. L. Rogers, the district sales manager, and any inquiries regarding the Stirling water-tube boiler will receive prompt and energetic attention.

—The Wellman-Seaver-Morgan Company, engineers and manufacturers, with general offices at Cleveland, Ohio, and plants at Cleveland and Akron, Ohio, have opened a New York office at 42 Broadway. Mr. Geo. B. Damon, who is a well known and able engineer, has been appointed New York manager, and any inquiries addressed to the New York office will have his immediate and personal attention.

—The Bristol Company, of Waterbury, Conn., have an exhibit at the St. Louis Exposition of recording instruments for pressure, temperature and electricity, located in the Electricity Building. The booth, which is 21 feet by 12 feet, and looks very attractive, contains a large variety of instruments which record continuously with ink, upon graduated, revolving charts, all changes that occur in pressure, temperature or electricity, so that a record of a period of 24 hours or more may be observed at a glance. Many of these instruments are in actual operation, and may be inspected by visitors to learn their manner of construction and the scientific principles upon which their operation depends, and the extreme sensitiveness and accuracy that it is possible to obtain in instruments of this character without rendering them too delicate for commercial application. Recording pressure gauges are shown for ranges from full vacuum to 10,000 pounds per square inch; recording thermometers and pyrometers for ranges from 60° F. below zero to 1200° F. above. The recording thermometers are made in many varieties of form to render them applicable to all industrial requirements, especially where it is desired to record temperatures at a distance from the source of heat. Recording volt, ampere and watt meters for both alternating and direct current are shown, including a great variety of ranges suited to commercial demands for different voltages and currents in electric light, power and railway plants. Recording water-level gauges are shown in operation, and also a new instrument designed as a thermometer-thermostat. This last instrument is so constructed that it may be used to give an alarm or set in operation temperature-regulating apparatus at any predetermined point of temperature. A full line of sizes of Bristol's patented steel belt lacing is also exhibited and includes styles for all varieties and thicknesses of belting.

—The Brown Corliss Engine Co., of Corliss, Wis., have recently received orders for one 24 and 44 by 48-inch tandem-compound rolling-mill engine for the U. S. Steel Corporation's McKeesport plant, near Pittsburg, and for one 30 and 60 by 48-inch tandem-compound condensing engine for the rolling-mill plant of the Jones & Laughlin Steel Co., of Pittsburg.

—The Wile Power Gas Company has been formed in Rochester, N. Y., to deal in gas producers for power and heating. This company will manufacture automatic gas producers, with patent regulator of the pressure type, of which over 1,000 horse power are now in successful operation in England. These producers will work with either coke, charcoal, anthracite coal, bituminous coal or wood. The Wile Power Gas Co. will also build suction gas producers designed by experienced gas engineers and embodying the best features of European practice.

—The American Blower Co., of Detroit, have recently opened a branch office at 1019 Empire Building, Atlanta, Ga.

—The electric wires in the cars on the N. Y. Rapid Transit Subway will run through the Sprague Company's flexible metallic conduit, which is extensively used in the best and most modern buildings throughout the country. Flexible metallic conduit is a tube formed by a succession of steel convolutions, which gives not only great flexibility to the tube, but, also, by reason of the metal composition, a thorough protection to the insulated wires which it carries. Injury from rodents or mechanical causes is thus prevented, and even a short circuit will produce no serious damage, so that safety to the passengers is insured and they have nothing to fear from fire caused by defective wiring.

—The Crocker-Wheeler Company, of Ampere, N. J., have seven of their standard railway-type generators, compound wound for 550 volts, in the Intramural Railway power plant, in Machinery Hall, at the St. Louis Exposition, in the following sizes: One 900-kilowatt unit, connected to an engine manufactured by the Buckeye Engine Co., of Salem, O.; one 600-kilowatt unit, driven by an engine of the Lane & Bodley Co., Cincinnati; one 500-kilowatt unit, with an engine made by the Murray Iron Works Co., Burlington, Iowa; two 500-kilowatt units, driven by engines of the Brown-Corliss Engine Co., Corliss, Wis.; one 400-kilowatt unit, with an engine from the Harrisburg Foundry & Machine Co., of Harrisburg, Pa.; and one 100-kilowatt unit, driven by a tangential water-wheel of the Abner Doble Company, San Francisco. These generators and engines, which have been in service but a short time, are all for sale, delivery to be made shortly after January 1, 1905.

—The Miami Commercial College, of Dayton, Ohio, has issued on attractive pamphlet, describing its course of study and showing the remarkable success achieved by its graduates, letters from many of whom are reproduced. This institution was established in 1860, and its principal officers at present are A. D. Wilt, president, A. D. Wilt, Jr., vice-president, and S. O. Albaugh, secretary.

—A meeting of a number of persons interested in cement and cement construction was held in St. Louis during the Engineering Congress, at which reports were made of the results of a canvass on the question of the formation of an association composed of users of cement. Several editorials have appeared in magazines suggesting such an association, especially in the September and October numbers of *Municipal Engineering*, published in Indianapolis. Circular letters have been sent to persons engaged in cement and concrete construction, especially in concrete block manufacture, asking for expressions of opinions regarding the time and place of meeting for the formation of such an association. A large number of replies to the circular letters have been received and as a result of this vote, it was decided at the meeting referred to, to issue a call for the convention of users of cement at Indianapolis, January 17-18-19, 1905. Arrangements were made for securing competent persons to speak upon the various subjects which will come up for discussion, and to arrange for the local entertainment of the convention, so that it may be successful in all its details. Further information regarding this convention may be obtained from Mr. Charles C. Brown, of 82 Commercial Club Building, Indianapolis.

—The Electric Controller & Supply Co., of Cleveland, announce the opening of their southern branch office at 509-510 Woodward Bldg., Birmingham, Ala. This company is now represented in the following cities: New York, Philadelphia, Pittsburg, Cleveland, O., Birmingham, Ala., Denver, Colo., San Francisco, and London.

—The Northern Electrical Mfg. Co., of Madison, Wis., recently shipped to the New York Edison Co. 34 of its variable-speed motors operating on the Northern two-wire field-control system. These motors will be directly coupled to blowers for cooling the transformers in the various sub-stations of the Edison Company. Nine small Northern motors were also shipped recently to be installed in the sub-stations of the Brooklyn Rapid Transit Co. This makes a total of 75 Northern motors, aggregating 1,500 horse power, now in use by the two above-named companies. A 60-kilowatt Northern balancing set has also been shipped to the New York Edison Co., for the equipment of its Waterside Station.

—The Power & Mining Machinery Company have recently closed a contract with Mr. James E. Hooper, of Baltimore, for a 25 by 30-inch, two-cylinder engine, and two suction gas producers, the plant to be installed in his new cotton mill at Woodberry, Baltimore. The engine as installed will have three rope pulleys for driving to the floors of the mill, and the shaft will be extended for a flanged coupling, so that another 25 by 30-inch, two-cylinder engine can be installed at a later date, it being Mr. Hooper's intention to double the mill after the first half is in operation. It is believed that this is the first installation of its kind for cotton mill work. The order was obtained after a very thorough investigation on the part of Mr. Hooper and his engineer, Mr. C. C. Hedrick, of the Lowell Machine Company.

—S. Pearson & Son, Incorporated, who are building the Pennsylvania Railroad tunnels under the East River and Long Island City, have just awarded the contract for two complete compressed-air power plants, ready to operate, to the Ingersoll-Sergeant Drill Company, of New York. The combined capacity of the plants consists of 50,000 cubic feet of low-pressure air per minute, and 12,000 cubic feet of high-pressure air per minute. It will be remembered that the same company recently received an order from the O'Rourke Engineering & Construction Company for the compressed-air plants to be used in building the Pennsylvania tunnel under the Hudson River. The contract just awarded is the largest order ever placed in the history of the business. These plants will be erected by the Ingersoll-Sergeant Drill Company, under the personal supervision of Mr. J. H. Jowett, the sales manager of the company.

—The New York Continental Jewell Filtration Company, of 15 Broad St., New York City, have an active demand for their water-purifying apparatus. Among their recent sales are the following: To apartment houses, residences, office buildings, etc.: Grand Hotel, Caledonia Springs, Quebec, Canada; St. Joseph's Hospital, Ft. Wayne, Ind.; New York Telephone Company, New York; N. Y. Magdalen Benevolent Society, Inwood, N. Y.; Racquet and Tennis Club, New York; Dr. Reginald Allen, J. C. Wilson, S. Geikler, Thos. W. Eynon, Mrs. Isaac Starr, Miss M. Grace Hall, C. J. String, Miss Hubbell, Rev. E. S. Lowery, W. H. Farwell, C. J. Hatfield, Mrs. Wm. McLean and Philip Wright, all of Philadelphia. To textile mills: Chas. H. Whitly & Brother, Philadelphia; A. H. Sims Company, Montreal, Canada; Laurens Cotton Mills, Laurens, S. C.; and P. & J. Coates Company, Ltd., Pawtucket, R. I. Miscellaneous: Eynon & Evans, (brass foundry), Philadelphia; Rotograph Company, New York; J. A. Roebling's Sons Co., Trenton, N. J., a second order; W. H. Tolhurst & Son, Troy, N. Y.; Lehigh Valley Railroad Company, Easton, Pa.; Freund Brothers, (photographers), Atlantic City, N. J.; Peter Breidt City Brewery Company, Elizabeth, N. J.; Crystal Ice & Power Company, (ice plant), Danville, Va.; Jerome Avenue Pumping Station, (boiler service), New York; R. H. H. Steele Laundry, Jersey City, N. J.; and The Orr Company, Troy, N. Y.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Aerial Tramways.

Pamphlet, containing illustrated descriptions of the Otto aerial wire-rope tramways for the transport of coal, ore, timber and other materials, in buckets, boxes, casks and chains, with views of installations in all parts of the world, these tramways running up 20 miles in length and having clear spans up to 3657 feet. 9 by 6 in., pp. 46. Otto Wire Rope Tramway Co., 225 Washington St., Chicago.

Ammonia Fittings.

Catalogue No. 2, containing illustrations, descriptions and prices of ammonia valves, flanges, couplings, elbows, tees, bends, headers, piping, safety gauge glasses and other ammonia fittings for ice-making and refrigerating plants. 9 by 6 in.; pp. 28. Vulcan Iron Works, San Francisco.

Ball Bearings.

Bulletins Nos. 1, 5 and 6, devoted to Auburn ball bearings, including ball thrust bearings, ball thrust washers and other styles, together with many testimonials from users. 9 by 4¼ in. Auburn Ball Bearing Co., Rochester, N. Y.

Building Construction.

Pamphlets describing and illustrating the rapid and efficient construction of the electrical engineering laboratory for the Massachusetts Institute of Technology, a plant for the Columbia Rope Co., of Auburn, N. Y., a concrete dam, power stations, hospitals, and other buildings and engineering works. 7 by 8 in. Frank B. Gilbreth, 176 Federal St., Boston.

Cableways.

Large and comprehensive catalogue, with halftone illustrations and descriptions of various forms of cableways for coaling at sea, loading and discharging vessels, handling logs, open-pit mining and quarrying, and constructing canals, dry docks, dams, locks, filter beds, piers and other engineering works. 11½ by 9 in.; pp. 160. Lidgerwood Manufacturing Co., 96 Liberty St., New York.

Coal-Handling Machinery.

Bulletin No. 047, illustrating and describing coal-handling machinery for power stations, boiler rooms, coaling stations, gas companies, coal yards, shipping docks, manufactories and other places. 5½ by 6¾ in.; pp. 48. C. W. Hunt Company, West New Brighton, Staten Island, N. Y.

Concrete-Steel Bridges.

Pamphlet, containing illustrations of many handsome reinforced concrete arch bridges, for parks, highways and railways, built on the Melan, the Thacher and the von Emperger systems. 5½ by 8 in.; pp. 36. Concrete Steel Engineering Co., Park Row Building, New York.

Electric Driving.

Bulletin No. 37, containing an account, with many illustrations, of the Northern variable-speed motor drive for machine tools, a system with a single-voltage electric motor operating on a two-wire circuit through a controller, thereby obtaining speed variations of 5 and 6 to 1. 10 by 7 in.; pp. 12. Northern Electrical Manufacturing Co., Madison, Wis.

Electric Generators.

Bulletin No. 49, containing illustrations and descriptions of seven standard Crocker-Wheeler railway-type generators, ranging from 900 to 100 kilowatts in capacity, six driven by steam engines and one by a Doble water wheel, which are in the power plant of the Intramural Railway at the St. Louis Exposition, and will be sold at the close of the Fair. 7½ by 5 in.; pp. 16, Crocker-Wheeler Company, Ampere, N. J.

Electric Machines.

Bulletin No. 1027, illustrating and describing alternating current generators and motors, of both belted and direct-coupled types, and their parts, with views of plants where they are installed. 9 by 6 in.; pp. 16. The Bullock Electric Mfg. Co., Cincinnati.

Expanded Metal.

Large, handsome pamphlet containing halftone illustrations and descriptions of the expanded-metal system of fireproof building construction for floors, roofs, partitions, ceilings, columns, walls, cornices, etc., theoretical and practical discussion of this method of construction, and views of many buildings and engineering works where it is employed. 12 by 9 in.; pp. 64. Expanded Metal Engineering Co., 256 Broadway, New York.

Fire Extinguisher.

Booklet, illustrating and describing Badger's fire extinguisher, which is compact and convenient, and by means of which a stream of water impregnated with carbonic acid gas can be thrown on a fire without delay. 6 by 3¼ in.; pp. 16. Badger Fire Extinguisher Co., Boston.

Flexible Transmission.

Bulletin No. 17, giving descriptions and illustrations of the Coates hardened-steel ball-bearing flexible shaft and its applications to drills, grinders and other tools and machines. 8 by 6 in.; pp. 16. Also, circulars devoted to the Coates' direct-drive coupling for automobiles and the Coates' ideal foundry equipment. Coates Clipper Manufacturing Co., Worcester, Mass.

Grab Buckets.

Pamphlet, with illustrations of grab buckets for handling coal, ore, broken limestone, gravel and sand, and for excavating in clay, gravel and soft earth of any nature. 8 by 4½ in.; pp. 12. The Jeffrey Manufacturing Co., Columbus, O.

Inspirators.

Catalogue, containing half-tone illustrations and descriptions of the Hancock inspirator, of the "stationary" and other types, ejectors, noiseless water heaters, swing check valve and their accessories, with views and description of the Hancock Inspirator Co.'s factory, history of the inspirator, and useful information. 6 by 9 in.; pp. 54. The Hancock Inspirator Co., 85-89 Liberty St., New York.

Locomotive Cranes.

Bulletin No. 4, giving comprehensive descriptions and illustrations of "Browning Standard" locomotive cranes, in several styles, and of their details. 9 by 6 in.; pp. 32. The Browning Engineering Co., Cleveland, Ohio.

Machinery.

Pamphlet entitled "What We Do," which gives some idea of the scope of the Wellman-Seaver-Morgan Company's work. There are illustrations and brief descriptions of steel works and steel-works machinery, gas-producer plants, cranes, ore and coal-handling machinery, coke-oven machinery, steam engines, gas engines, water turbines, mining machinery, and other kinds of machinery and engineering works. 9¼ by 4 in.; pp. 36. The Wellman-Seaver-Morgan Co., Cleveland, Ohio.

Mining Machinery.

Bulletin No. 101, containing illustrations and descriptions of electrically-driven air compressors, mining hoists, pumps, blowers and exhausters and other machinery for use at mines, with remarks on electric driving. 9 by 6 in.; pp. 24. Harron, Rickard & McCone, San Francisco.

Narrow-Gauge Railways.

Booklet, containing article entitled "On the Track," by Ernst Wiener, reprinted from *Cassier's Magazine*, and descriptions and illustrations of narrow-gauge railways and cars for industrial works, mines, and many other purposes, both in and out of doors. 6¼ by 3½ in.; pp. 24. Arthur Koppel, 66-68 Broad St., New York.

Plate Construction.

Large pamphlet, containing handsome half-tone illustrations of modern blast-furnace plants, cinder and hot metal cars, steel mixers, and other examples of steel and iron plate construction. 9 by 11 in.; pp. 63. The William B. Pollock Co., Youngstown, Ohio.

Precision Machinery.

Catalogue giving illustrations, construction details and principal dimensions of precision machinery, including bench lathes, with many attachments, automatic pinion cutters, automatic gear cutters, drilling and tapping machines, and bench milling machines. 9 by 5¾ in.; pp. 59. Sloane & Chace Manufacturing Co., Ltd., Newark, N. J.

Pumping Machinery.

Large pamphlet containing an illustrated reprint from *The Iron Age* on "Pumping and Air-Compressing Machinery at the St. Louis Exposition," which describes the pumping plant for the great cascades, sewage pumps, a model irrigation plant, condensing apparatus and cooling towers, compressed-air plants, and many other kinds of pumping machinery. 12½ by 8½ in.; pp. 16. International Steam Pump Co., 114-118 Liberty St., New York.

Catalogue with illustrations and descriptions of condensing machinery, including jet condensers, surface condensers, cooling towers and air pumps of various kinds, as well as vacuum pumps for evaporating apparatus. 7 by 6 in.; pp. 56. Also, "Pony" catalogue No. 44, containing descriptions and illustrations of steam pumps for a great variety of purposes. 6 by 3½ in.; pp. 64. Dean Bros.' Steam Pump Works, Indianapolis.

Recording Electric Meters.

Catalogue No. 16, with illustrations, descriptions and prices of recording volt meters, ampère meters and watt meters, their charts, cases and other accessories, facsimiles of records, tables of dimensions, diagrams of connections and other information. 12 by 9 in.; pp. 40. Also, bulletin No. 17, illustrating the Bristol Company's exhibit at the World's Fair, St. Louis. The Bristol Company, Waterbury, Conn.

Steam Engines.

Pamphlet describing tests of a Reeves simple engine, made by Professors Carpenter and Diederichs at Cornell University, which gave excellent results. 9 by 6 in.; pp. 4. The Reeves Engine Co., 85 Liberty St., New York.

Bulletins Nos. 162, 163 and 171, devoted to vertical steam engines, and Bulletin No. 164, to horizontal engines, with many illustrations, these engines being especially designed for driving blowers and fans. No. 171 also describes a new and effective system of automatic lubrication for vertical high-speed engines. 9 by 7 in. Also, booklet No. 70 devoted to fans and blowers. 4½ by 3½ in.; pp. 32. American Blower Co., Detroit.

Steam Specialties.

Price list No. 11, with illustrated descriptions of "K. & T." pressure regulators, continuous-discharge steam traps, noiseless back-pressure valves, and automatic relief valves, Metz pump governors, Vaters' two-stage steam separators, and other steam specialties. 9 by 6 in.; pp. 8. Klipfel Manufacturing Co., 74-76 W. Lake St., Chicago.

Storage Batteries.

Booklet, containing descriptions, with illustrations and diagrams, of "chloride" accumulators in various styles, for railway power plants, rotary-converter substations, automobiles and other uses, with tables and useful information in convenient form. 3 by 5½ in.; pp. 42. The Electric Storage Battery Co., Philadelphia.

Switchboards.

Bulletin No. 20, containing descriptions, illustrations and prices of "Security" panel boards for electric switches, fuses and connections. 10 by 7¼ in.; pp. 20. Also, card illustrating the "Special" dry battery. The F. Bissell Company, Toledo, Ohio.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Pelton Water Wheel.

AS is doubtless known, the impulse wheel, of which the Pelton is the pioneer, consists essentially of a cast iron or steel center, to the periphery of which are affixed cups or "buckets" as they are technically called. Water under pressure is allowed to impinge on these buckets, causing the wheel to revolve with the shaft on which it is mounted.

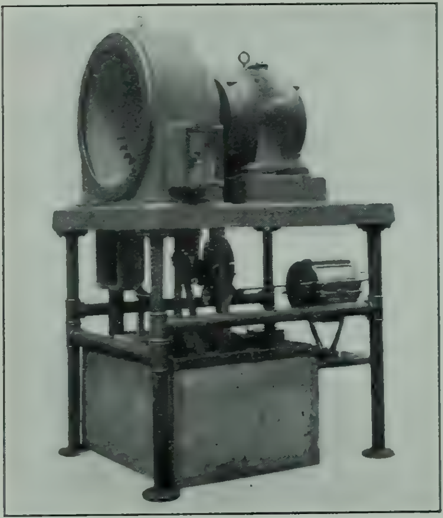
The efficiency of a wheel of the Pelton type is, to a very large extent, due to the shape of the bucket, and as efficiency is a most important factor in the development of every power proposition, it is the bucket and the action of the water upon it which engage the most attention.

One of the fundamental principles of hydraulics as applied to impulse wheels, is that the water must "enter without shock and leave without velocity." The nearer the approach to this condition, the higher will be the resultant efficiency. Early experiments with the Pelton bucket demonstrated the fact that in order to obtain a complete reversal of the stream, with practical absence of velocity, it was essential that the bucket be divided into two parts, by a wedge or splitter on which the stream might strike. The stream of water was thus divided, the two halves following the curvature of the bucket and discharging backward and downward at a slight angle, so as to avoid interference with the succeeding bucket. To obtain this result, it is necessary that the bucket curves be laid on lines of the least resistance and that the splitter bear a certain relation to the bucket sides.

In designing a water-wheel bucket and attempting to carry out a particular theory, it is, of course, necessary to lay out the bucket shape mathematically, and then, following well known hydraulic laws in regard to the flow of water on surfaces, note the curves and paths which the stream should follow. This plan—the only one heretofore known—has been productive of some excellent results, but the fallacy lies in the fact that most of the hydraulic laws above referred to were deduced from observations of water action against *stationary* surfaces; or, if moving, the path of the water was so obscured by spray and the moving wheel, that the observations have in some cases led to mistaken theories, which are now disproved in actual practice.

SKORISCOPIC VIEW OF PELTON WHEEL IN OPERATION.

The problem is, then, to observe the action of water on moving surfaces as though

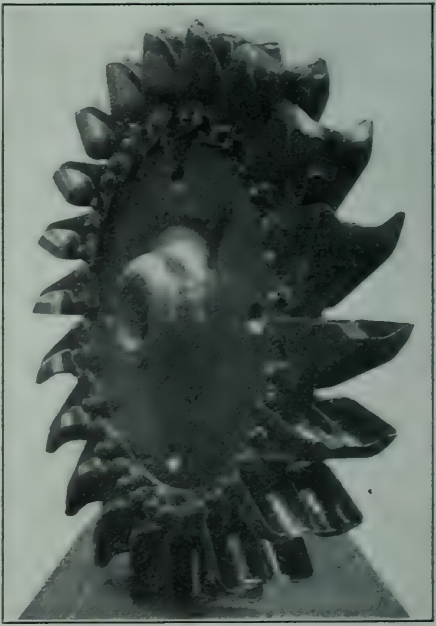


SKOBISCOPIC APPARATUS FOR PELTON WHEELS.

they were standing still. This is accomplished by applying the "skobiscopic" principle to the observation of a water wheel in actual operation, which principle may be described as being the reverse of the kinetoscope, in that moving objects are seen as stationary, instead of apparent motion being given to stationary objects. The general principle is that if a moving object be illuminated at fixed intervals by rays of light admitted at the moment the object passes a desired position, each portion of the object will be observed as though it were stationary. Thus is secured a clear view of what occurs in the buckets of a water wheel while it is operating under normal conditions.

The Pelton Water Wheel Company has made extensive experiments on a large scale at its San Francisco laboratory with apparatus embodying the above principles, and has also shown similar apparatus on a smaller scale in action at the St. Louis Exposition. The latter outfit consists of a Pelton water wheel 20 inches in diameter, mounted on the shaft overhang of a General Electric generator. The water impinges on the wheel through a needle nozzle, the pressure being supplied by a centrifugal pump. The illuminant is a General Electric searchlight projector with automatic focal point control, which is located beneath the apparatus, and which by a system of mirrors, throws its rays into the wheel housing through the glass bottom. In its normal position the light is thrown direct on the wheel, under which condition the wheel may be seen revolving and the water discharging from the buckets in apparent confusion. Interposed between the searchlight and the wheel is a sheet iron disc with radial slots, which disc is revolved by means of gearing at a speed proportional to that of the wheel, and when the searchlight is automatically brought into its upper position, the light is thrown on the wheel *through* these revolving slots, and thus the wheel is illuminated at fixed intervals, as explained above, and one sees the wheel apparently standing still and can observe the action of the water and trace the path of the jet from its entering the bucket to its reversal and clearance of the succeeding bucket, without interference.

At the San Francisco laboratory of the Pelton Water Wheel Company reliance is not placed on visual observations alone, but resort is had to photography as a permanent aid in studying the action of the water on the buckets. In this laboratory also are instruments of precision for determining the relative efficiencies of different bucket shapes; and to such an extent



4,000 HORSE-POWER PELTON WHEEL.

is the investigation carried that it may be said that there are practically no "standard" buckets used in the construction of Pelton wheels, a new design being adapted to the head, water quantity and power requirements of each installation, thereby insuring the highest possible efficiency.

Further information about these investigations and their apparatus in general may be obtained from the Pelton Water Wheel Company, of San Francisco.

The Saving of Oil By Filtration.

IN every engine room, and indeed, in every factory and mill where a large amount of machinery, and long lines of shafting, are in operation, there is a great waste of lubricating oil, owing to the fact that in many instances no provision is made for catching the oil after it passes through the shaft or engine bearings. This is often due to the style of bearing used on the shaft lines, but where suitable self-oiling bearings are installed and provision made for catching the drippings which accumulate in the drip cups, or where provision is made for catching the oil after passing through the engine bearings and then purifying these drippings through an oil filter, a surprise is in store for the manager in the shape of a great reduction in the size of his oil bills for the month.

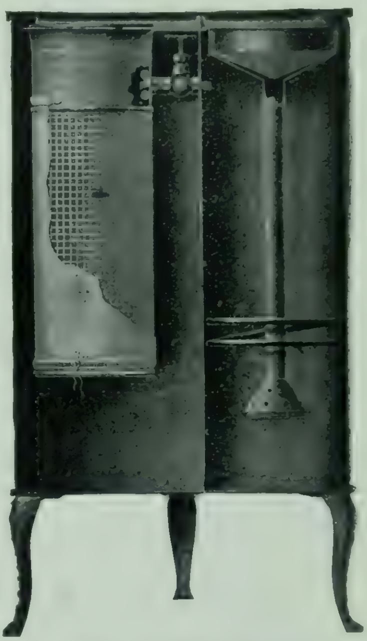
Every engineer appreciates the value of good oil and asks his employer to procure the best in the market for lubricating purposes, for the proper preservation of machinery in his care demands it. Getting a good grade of oil, the engineer will naturally be glad to use some filtering device for purifying the oil which has passed through the bearings, thus permitting its use over and over again.

An interesting test conducted by users of the White Star oil filter as manufactured by the Pittsburgh Gage & Supply Co., was recently conducted, and in the case of O. J. Beaudette & Co., of Pontiac, Mich., it was found that in the first six months operation of the White Star filter, a saving of 364 gallons of oil, of a value of $54.60, was effected. As the original cost of the filter was but $28, the effectiveness of the device and profitableness of the investment is apparent.

Another instance of interest is the experience of the City Water Works, of Marietta, Ohio, where, before purchasing a White Star filter, they were consuming a barrel of oil every two months, but with the filter in use a barrel now lasts them four months.

The effectiveness of any device depends upon its design, construction and workmanlike qualities, and in the White Star oil filter is found the essentials of a complete device for accomplishing the purifying of dirty, or used, lubricating oil.

As seen in sectional view, the filter is divided into two compartments. The smaller one is a reservoir for impure oil and water, containing a funnel for receiving the dirty oil and the steam coil for heating the water.

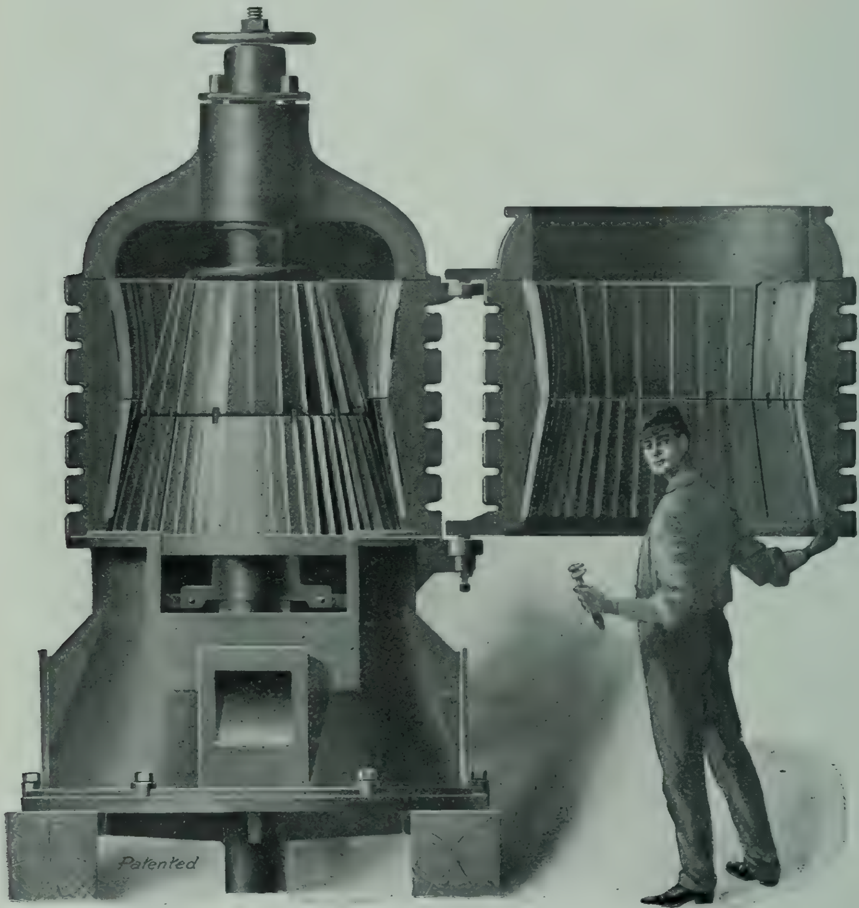


WHITE STAR OIL FILTER.

Impure oil is poured into the funnel, drains through the sieve and is discharged below the surface of the water through holes in the foot of the tube. The thinning of the oil by its exposure to the heat in passing through and resting on the surface of the water promotes the precipitation by gravity of all heavy particles of grit and dirt, the accumulation of which at the bottom can be quickly flushed out by opening the faucet for this purpose, which may also serve to drain off any excess of water in the chamber.

When sufficient impure oil has beeen introduced to reach the level of the inlet pipe, it flows into the filter cylinder which is suspended in the larger compartment. This cylinder is unique in that it consists of a sheet metal neck and bottom with a section of coarse wire mesh between, around which several layers of cloth are wrapped. The oil in passing out of this cylinder through the cloth is thoroughly and quickly freed of every remaining impurity and accumulates in the surrounding chamber, which comprises the remaining two-thirds of the filter, so giving the White Star filter a great storage capacity for pure oil.

The filtering cylinder and every part of the filter may be quickly and easily removed and cleaned, enabling the apparatus to be always kept in perfect filtering condition. In this most essential feature of a perfect and complete device the White Star oil filter is unsurpassed, and further particulars will be furnished on request by the Pittsburgh Gage & Supply Co., of Pittsburgh.



STURTEVANT OPEN-DOOR ROTARY CRUSHER.

Open-Door Rotary Crushers.

A NEW rotary crusher is manufactured by the Sturtevant Mill Company, the ingenious and practical design of which will certainly interest all crushers of materials of moderate hardness. It is called the open-door rotary fine crusher, and its massive door, swinging wide as easily as the great door of a large safe, exposes all its wearing parts to quick inspection and removal. It is obvious that railway links, coupling pins, and all sorts of uncrushable materials that get into this class of machines, and are so difficult to get out, may in this machine be removed in short order.

Also, the heaviest wearing parts, although massive, are small enough to be lifted out by hand, obviating the necessity of the hoisting appliances in common use. These crushers are large, and yet far more convenient than others of even small size.

Rotary crushers are the greatest producers known of finely broken materials of moderate hardness, and are more widely used than any others. They have held their own against all comers, notwithstanding the frequent annoyance of having to dismantle them completely to remove foreign material getting wedged among the crushing members, for they crush cheaply, and crush fine, and are the least expensive in first cost as well as in power. But for big works they could not be made large enough until this open-door crusher was designed.

The vertical shaft carries only its own weight and that of the driving gear; and its foot runs in a large oil-pot bearing thoroughly protected from dust. The crushing cones are supported from the top by large ball bearings, which greatly promotes easy running and durability. These cones may be raised or lowered by the screw at the top. The range of adjustments for wear, or for size of output, is unusually large.

The scrapers require no change, except replacement for wear, and are conveniently reached without dismantling the machine. The cast-steel bevel pinion shaft is supported from the inner end, so giving great strength to this important part. Discharges are from three sides. The door bolts are removed from slots, a single turn of each nut allowing speedy removal, and thus the door may be opened as easily as the door of a steel safe, and swung entirely out of the way, giving full access to the interior of the crusher. Removal of any part is therefore easy. The case is not weakened by the door which, held by its bolts, is rigid and secure.

Having no fly wheel, this crusher is not subject to breaking fly-wheel shocks in case of sudden stoppage. This danger is avoided, and yet the machine has abundant power for any work.

Every part of the open-door crusher is massive; the main shaft is 7 inches in diameter, and in every way strong and reliable.

The Sturtevant Mill Company, of Boston, have just issued their 1905 Catalogue No. 12, showing and describing these rotary crushers and eight other types of rock crushers, as well as rolls, mills, screens, engines, boilers, etc., and they will be pleased to mail this catalogue to interested persons.

Employees' Automatic Time Register.

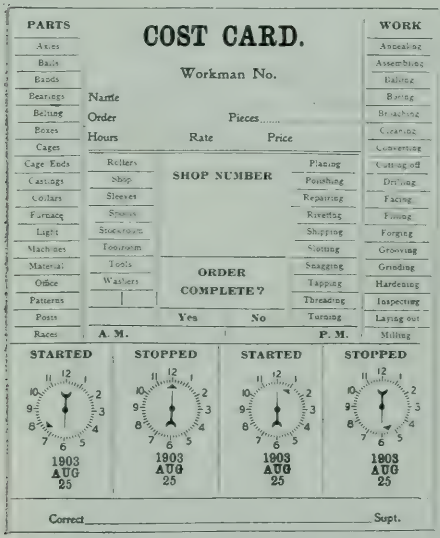
IN the modern systems of works management it becomes of the highest impor- of every operation, as well as to register the tance to keep an accurate record of the time there have been several machines designed to perform one or the other of these functions.

An apparatus which will accomplish both these results is shown in the accompanying illustration. For registering the coming and the going time, it is operated by the employee taking a ticket bearing his name or number, or both, from a pigeonhole similarly marked and inserting it in the time-stamping slot and pushing a trigger lever which imprints the exact hour and minute and the date upon it.

EMPLOYEES' AUTOMATIC TIME REGISTER.

The daily-strip ticket usually has room for four "In" and "Out" impressions, and the weekly strip is designed to receive twenty-four impressions, but the number of time-imprint spaces may be varied as required.

This machine is also most convenient in cost-keeping systems for recording the time required on any operation, and in establishments where the workmen make out a daily report slip of their work and time, their "In" and "Out" records can also be registered upon it, and will thus verify their reported time without adding to the clerical work or increasing the expense in any way. A typical cost card is shown in one of the figures.



PARTS
Axles
Balls
Bands
Bearings
Belting
Boxes
Cages
Cage Ends
Castings
Collars
Furnace
Light
Machines
Material
Office
Patterns
Posts
Races

COST CARD.

Workman No.

Name
Order Pieces......
Hours Rate Price

Rollers
Shop
Sleeves
Spools
Stockroom
Toolroom
Tools
Washers

SHOP NUMBER

ORDER COMPLETE?
Yes No

Planing
Polishing
Repairing
Riveting
Shipping
Slotting
Snagging
Tapping
Threading
Turning

WORK
Annealing
Assembling
Baking
Boring
Broaching
Cleaning
Converting
Cutting off
Drilling
Facing
Filing
Forging
Grooving
Grinding
Hardening
Inspecting
Laying out
Milling

A. M. P. M.

STARTED STOPPED STARTED STOPPED

1903 AUG 25 1903 AUG 25 1903 AUG 25 1903 AUG 25

Correct______________________ Supt.

COST CARD OF THE AUTOMATIC TIME STAMP COMPANY.

It is evident that this machine may be worked with a variety of specially arranged tickets, as may be desired. As the vertical spacing lines on the tickets coincide with gauging pieces on the machine, the tickets can be quickly placed in the proper printing position without the slighest difficulty.

This machine is of very simple construction, the number of parts being small and the operation not at all complicated. Further details and all other information desired will be furnished on request by the manufacturers, The Automatic Time Stamp Company, of Boston.

Revolving-Cylinder Gasoline Motor and Car.

A REVOLVING-CYLINDER, air-cooled, gasoline motor, which is claimed to have distinctive advantages because of its compactness, its perfect balance, light weight, wide range of speeds and power and practical air-cooling qualities under all conditions, has been brought out by the Adams Company, of Dubuque, Iowa.

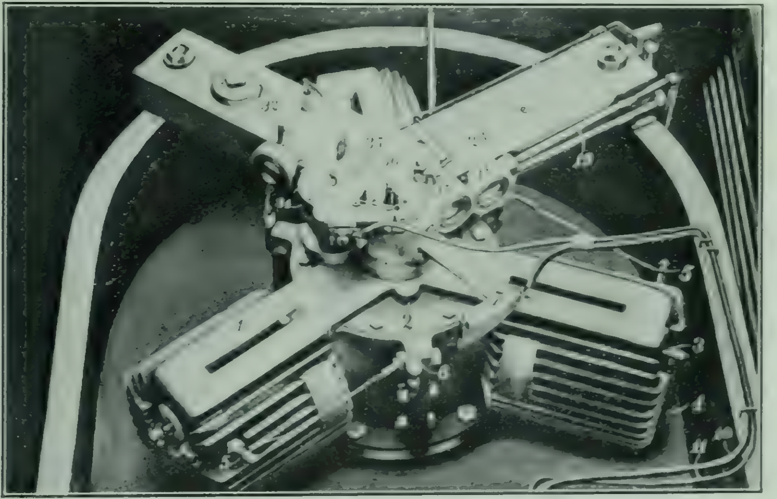
It reverses the ordinary practice, in that the engine cylinders revolve and the crank shaft is stationary, instead of the crank shaft revolving and the cylinder being stationary, but it is not what is usually termed a rotary engine. Three units, each being a complete cylinder, with cylinder head and one-third of a central crank case cast in one piece, are bolted together and bolted to a top and bottom cast-steel flange, which has bronze bushings forming bearings around the vertical stationary crank shaft. This forms the revolving unit and is, of course, balanced perfectly. This revolving unit in a twenty-horse-power engine, with 5-inch bore and 4½-inch stroke, weighs 190 pounds and forms the fly wheel.

In each cylinder is a cast piston having four rings. The three pistons are connected to a single crank wrist pin of very large proportions by bronze pitmans. The pitmans, with the piston at their outer end, swing around the stationary wrist pin in practically perfect mechanical balance. The wrist pin being eccentric with the axis of the revolving cylinder unit, the pistons are caused to reciprocate back and forth in the cylinder at each revolution of the revolving unit, although the speed of the mass of the pistons does not change or stop and return at each dead center, as with the ordinary engine. It is, therefore, susceptible to a very perfect mechanical balance. The action of the exploding charge is practically the same in this engine as in the ordinary kind, except for the smooth running caused by the variable-compression control.

The lack of vibration of the motor is attributed to the perfect balance of the revolving parts, the manner of revolving the cylinders in a horizontal plane around a vertical axis and the novel way of controlling the speed of the motor by a variable compression system.

The light weight of the motor, as compared with the three-cylinder motor of the ordinary type having the same power and cylinder sizes, is brought about, not by sacrificing the strength of any of the parts, but by eliminating many parts found necessary in the engine of the ordinary type.

No muffler is employed. Because of the velocity of the cylinders passing through the air a muffler of the ordinary type may be entirely dispensed with. Auxiliary exhaust ports, which let out the high terminal pressure against the rapidly receding volume of air, are used. The discharge acts upon the air like a sky rocket and not like a gun.



ADAMS-FARWELL REVOLVING-CYLINDER GASOLINE MOTOR.

Air cooling is effectually accomplished by the cylinders revolving at a rapid rate, drawing in the air at the center of the engine, or inner ends of the cylinders, and expelling it with great rapidity at the periphery, or outer ends of the cylinders. The cylinders are provided with longitudinal ribs cast integral with the cylinders, which provide a large radiating surface.

The speed of the motor is controlled entirely by the Adams-Farwell variable-compression system, which consists in allowing that part of the charge not needed to give the motor the required power to escape back by the inlet valve, which is mechanically held open for a part of a compression stroke; that part of the charge so escaping being drawn in by another cylinder. There is no waste of the gases. When the maximum power is required the inlet valve is closed at the end of the suction stroke and the full charge is compressed to about 95 pounds per square inch. When minimum power is wanted, the inlet valve is not closed until the completion of the compression stroke, and an exceedingly small part of the charge is retained and ignited at atmospheric pressure, giving a gentle expansion. Variable compression is the entire source of control. This system of control is claimed to be very economical, to be conducive to very smooth running, to obviate the necessity of heavy exhaust valve springs, to run much cooler and to keep the cylinder heads and spark plugs entirely free from sooty deposits.

The carburetter is entirely automatic at all speeds, no attention being required after once adjusting.

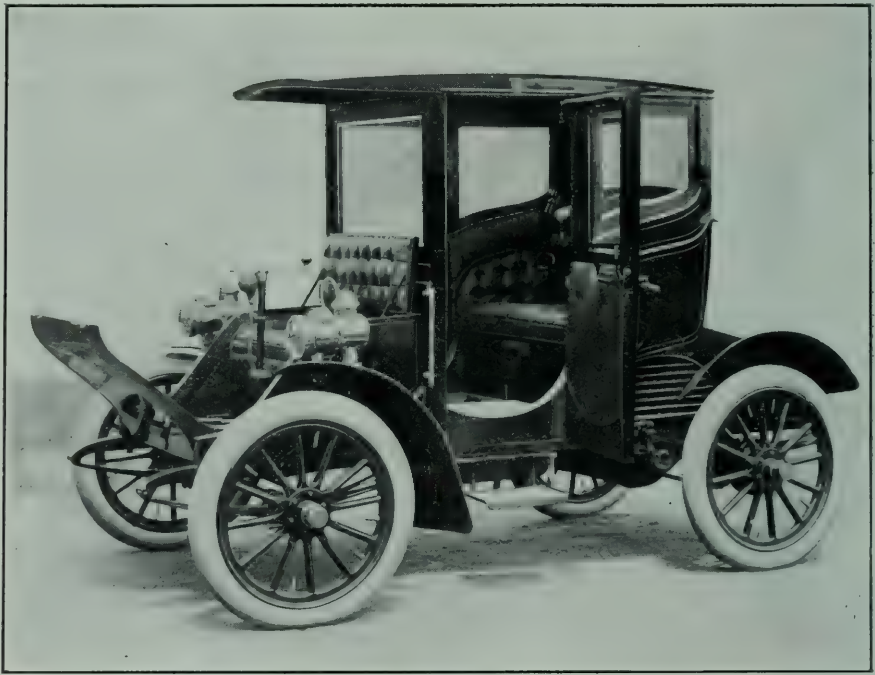
The spark is regulated automatically by the Adams-Farwell automatic spark regulator, which fires the charge at all speeds at a point that produces the greatest efficiency. This is a device employing a centrifugal governor which not only advances the spark when the speed of the engine increases, but also increases the length of the contact of the primary circuit. A contact of the primary circuit for 1-36 of a revolution of the engine gives sufficient time for the spark coil to become saturated and give a good spark when the engine is running 150 revolutions per minute, or less. This contact is automatically increased to about 1-12 of a revolution of the engine when running at 900 revolutions per minute.

One of the illustrations shows the motor as situated in the rear of an automobile body, where every part of the motor proper that will ordinarily require examination or adjustment is exposed to view and is readily accessible, as well as every tool required in these adjustments, each in a separate pocket, so that a glance will tell if all necessary tools are aboard. Two sets of batteries, a spark coil and a double-throw switch, and a few extras also find a place in the rear compartment of the car body.

The complete power plant, including all parts of the motor, transmission, oil tank and pump, carburetter, clutch operating cams, and so forth, are secured to the bronze supporting spider, forming an integral power unit weighing 387 pounds. Of this, 157 pounds belongs to the parts of the transmission which would not be needed if the motor was used for other purposes than that of automobile propulsion. Of the 230 pounds, the weight of the motor proper, 190 pounds are in the cylinders and other parts forming the revolving unit or fly wheel.

Another illustration gives a view of a convertible brougham equipped with the gasoline engine which has just been described. This car, known as Model 6, which is the latest style built by The Adams Company, is enclosed by plate glass in substantial frames, sliding in rigid pillars which support a solid roof, and makes an ideal vehicle for all seasons.

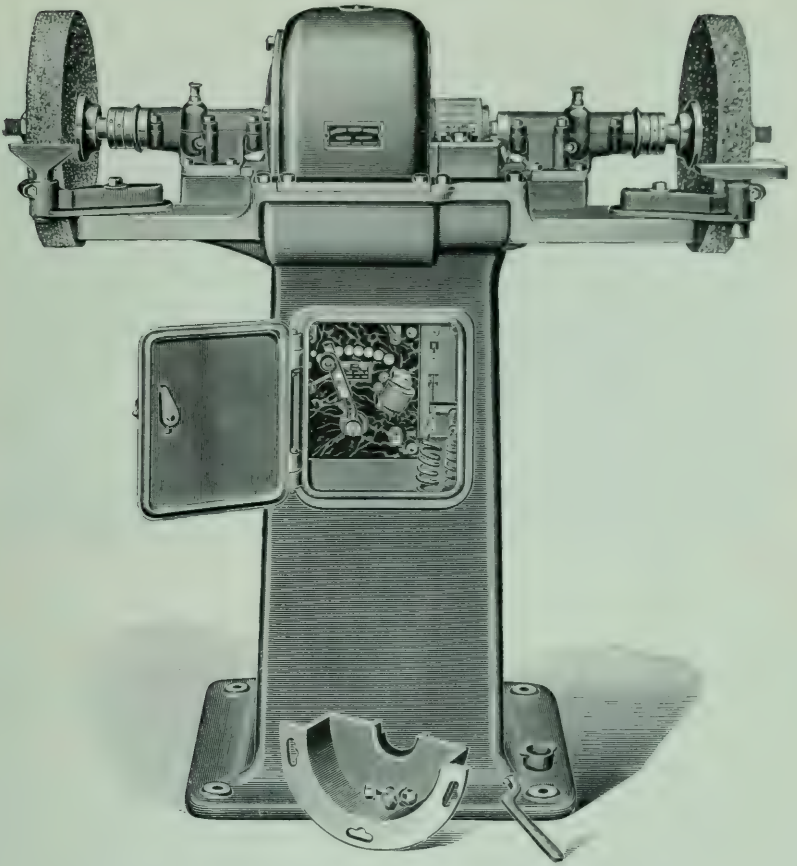
As shown, the forward seat is open and the car is operated from there, but this seat can be folded up so as to form a hood and the controlling levers can be moved to the rear.



ADAMS-FARWELL CONVERTIBLE BROUGHAM WITH GASOLINE MOTOR.

All the novel features of these motors and cars, such as revolving the cylinders around a vertical, stationary crank shaft, the system of muffling, variable compression control, automatic spark regulator, control from either front or rear seat, variable-strength springs, carburetter, oiling system, etc., are the subjects of patents granted and pending in the United States and foreign countries.

Further information concerning these gasoline engines and their various styles of automobiles may be obtained from The Adams Company, of Dubuque, Iowa.



ELECTRIC MOTOR-DRIVEN GRINDING MACHINE

fully inclosed and the problem of cooling by air is a serious one. This has been solved by having the lower half of the motor open directly into the base casting. The air contained in the inside of the base is thus added to the quantity that circulates around the inside of the motor, and enables it to run much cooler than an ordinary fully inclosed motor of the same size and capacity. By this means of inclosure from five to eight times as much cooling air is available as in ordinary fully inclosed motors of equal power, the base also giving an increased surface from which to radiate the heat.

The armature and brush mechanism is covered with an end shield, split horizontally. The lower half contains the brush holders and wire connections; the upper half is attached to the motor frame by cap screws. This upper half of the frame can thus be readily taken off, giving quick and easy access to the armature and brushes.

The machines are equipped with ring oiling bearings. On the outer end of each box is a dust-proof collar, held in place by a key with two ring nuts, to compensate for all end wear and thrust of the spindle. The machines are strong, rigid, compact and self-contained. All wires and connections being inside, a short circuit through outside terminals is impossible. The starting box and switch are inside the base and are easily reached by the operator through a door. The machines can be used with either underneath or overhead wiring as desired, and are complete with starting-box with no-voltage release, knife switch, and fuses ready to connect line wires.

Any further information desired will be gladly furnished by the Crocker-Wheeler Company, of Ampère, New Jersey.

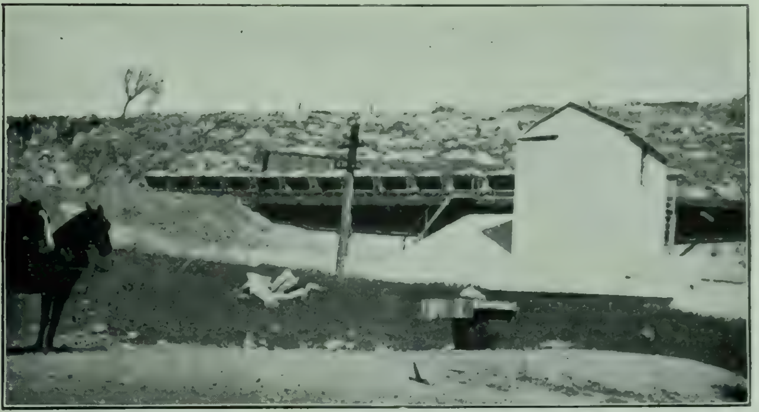
NARROW GAUGE RAILWAY IN CEMENT QUARRY.

Narrow-Gauge Quarry Railway.

THE accompanying illustrations show an a complete railway installed and equipped by Arthur Koppel in a cement quarry. This railway consists of 25-pound rails spiked down to wooden ties for the permanent road, and 16-pound portable track for use in transporting the rock from where it is quarried to the permanent road. The portable track is made in sections, each weighing about 250 pounds, and mounted on steel ties, so that it can easily be laid, without any previous preparation of the ground, and can readily be moved from place to place as required.

Eight switches for use with this portable track were also furnished. These switches are made as standard in two different lengths, viz., 9 feet and 15 feet, to match track, and for 12-foot and 30-foot radius.

CEMENT QUARRY RAILWAY.



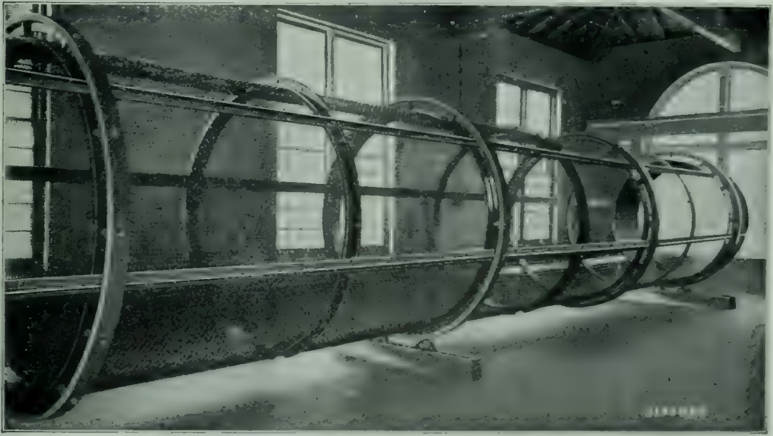
CEMENT QUARRY RAILWAY.

There were also furnished thirty standard steel side-dump cars, dumping to both sides, each with a capacity of 1½ yards. These cars were fitted with Arthur Koppel's patent roller bearings, which effect a saving of about 50 per cent. in haulage power over cars fitted with ordinary axle boxes. These bearings are practically dust and dirt proof, but can readily be cleaned when necessary. There is also a considerable reduction in consumption of oil, as none is required for lubrication, only just sufficient oil being put into the bearings to prevent the rollers from rusting. All this material was for the Koppel standard narrow gauge of 23⅝ inches.

This system of narrow-gauge railways is suitable for all classes of manufacturing, mining, building, contracting, etc.; a large saving can be made and materials can be handled quickly, economically, safely and systematically by installing such a road. Further information and a complete catalogue will be sent on request by Arthur Koppel, of 66 and 68 Broad St., New York.

Large Revolving Screen.

THE accompanying illustrations show extraordinarily large revolving screen, 7 feet in diameter and 54 feet long, mounted on friction rollers. This screen is for separating coal into a number of sizes and was built especially for one of the large coal companies in Virginia.



THE JEFFREY REVOLVING SCREEN.

When installed at the mine the screen will have no central shaft, but will be supported on heavy friction rollers, carried on

THE JEFFREY REVOLVING SCREEN.

shafts extending the full length of the screen. By rotating these shafts the motion is imparted to the screen by the friction rollers on the shafts bearing against the friction rings which are attached to the outside of the screen.

The coal is fed into the screen by means of a special bucket elevator at the rate of about 250 to 275 tons per hour.

This type of screen is also used, in a large number of mills, for screening shavings in great quantities.

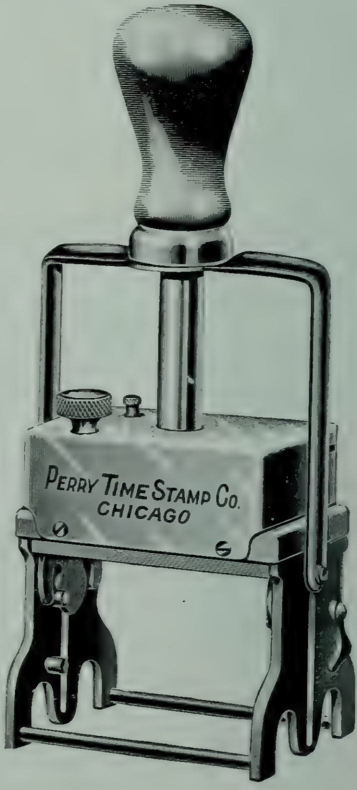
Further information concerning this giant screen as well as their many other products will be furnished, upon request, by the Jeffrey Manufacturing Company, of Columbus, Ohio.

The Perry Time Stamp.

A TIME Stamp which will print anywhere, on anything, without the clock work receiving the least shock or jar in the operation of positioning the Stamp and making the impression, must be pronounced perfect if there can be such a thing. Furthermore, when all this is achieved without complexity or weakness, it leaves little to be desired.

The Perry Time Stamp Company has accomplished all this in their model "C" Stamp, which resembles the well known, long tried, successful self-inking Stamp, the difference being that the Time Stamp is very much heavier and stronger in all respects and is provided with clock work and dials.

The clock work is mounted upon the base plate which joins together the two side frames. Intervening between the clock work and the base plate is a series of springs. These springs receive and absorb all jar or shock there may be when the stamp is placed upon the document, time card, box or parcel receiving the impression. Further, the blow or pressure given the handle to make the impression passes by on either side of the clock work directly to the type plate and is received by the object stamped and its support. By this construction, the unavoidable jar or shock in making an impression cannot reach or affect the clock work in the least.



THE PERRY TIME STAMP.

The ink pad is in its usual location on the bottom of the base plate. On the type plate is a simple dial train, the hour, minute and A. M. and P. M. hands of which rest against small circular rotating ink pads thereby putting no drag or work upon the clock motor.

The impression is made from rubber type, which prints more distinctly and wears better than the usual ribbon.

The hands in the dials are firmly locked in position the instant the type plate leaves the ink pad, thereby making it impossible for anything but the correct time to be registered. No one can tamper with the clock or alter its time, unless in possession of a special setting key provided by the manufacturer with each stamp.

The clock work is an excellent timekeeper. It should be wound each morning, the operation taking but a few seconds. The year, month and day are set by hand, a simple process common to all dating stamp.

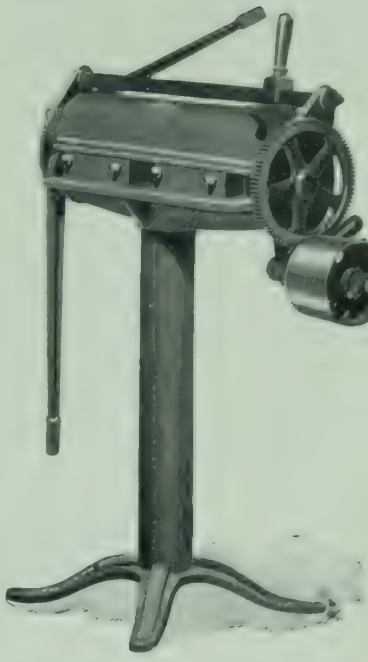
These stamps have had the test of severest usage for almost one year in such places as the Chicago Stock Yards, where several thousand impressions are made daily, with the result that they have proven a durable, reliable and valuable device. With ordinary use they should last several years. The manufacturers guarantee them absolutely for one year.

This stamp makes it possible for the small manufacturer to introduce into his office and his works the many excellent cost keeping systems, nearly all of which call for an expensive clock or recorder. It also makes it possible for the larger institutions to introduce the time stamp into other departments where they have been prevented from so doing on account of the large expense involved in the introduction of the electric and other clocks. Besides being a simple, practical and effective business machine, the stamp is also an ornament to anyone's desk.

Any further details of construction or use of the stamp will be cheerfully furnished by the manufacturers, the Perry Time

The advantages of mechanical recorders of time are being more and more appreciated everywhere, and this improved machine will doubtless be welcomed.

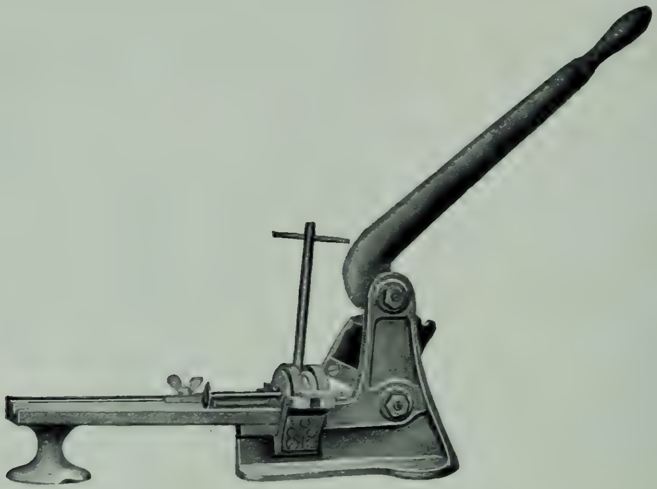
Stamp Co., 72 South Canal st., Chicago.



The Jackson Belt Lacing Machine.

THESE machines are built in four sizes, 6″, 12″, 18″ and 24″. This designation of sizes in inches arises from the maximum width belt each machine is capable of lacing. The machines are operated by hand, though the two larger sizes are equipped with power equipment if desired. These machines will lace belts made of any material.

The operation consists first in squaring the end of the belt by means of the cutter bar seen on top of the machine and a specially constructed knife furnished with the machine. The end of the belt being made square, the belt is clamped firmly between the jaws by means of the levers and the end punctured by means of a spiral needle. The needle is driven ahead by means of three grooved rollers which are revolved by means of the crank. Following the needle the coiled wire is inserted and enters the holes punctured in the belt by the needle. The lacing being in the belt it is removed and the surplus wire cut off with pliers. The wire is then flattened between the jaws until it is flush with the surface of the belt. The other end of the belt being laced in a similar manner, the two ends of the belt being brought together, the lacing meshes and the ends are held together by means of twine, lace leather, raw hide or metallic pins. This lacing costs one-fourth as much as lace leather or clamps per inch of belt. It lasts several times longer and can be inserted much more quickly and is equally as efficacious as endless belts. Further information may be had from the Diamond Drill and Machine Co., Birdsboro, Pa.



THE POOL ROD CUTTER AND POINTING MACHINE.

The Pool Rod Cutter and Chaplet Pointing Machine.

THE machine consists essentially of a pair of knives, and a chuck for holding the chaplets.

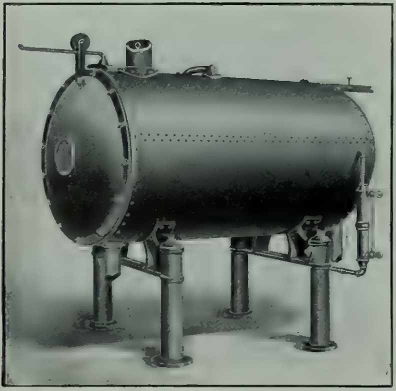
There is a gauge on the machine showing the length chaplet will be after it is pointed.

In operating it, the chaplet is first placed in the chuck, and a downward stroke of the lever makes a beveled cut on the end of the chaplet. The chuck and chaplet are then rotated through an arc of 90 degrees and another cut made. This work has heretofore been done either by the blacksmith, or on an emery wheel, and much time has been lost in doing this work.

This machine is made by the J. D. Smith Foundry Supply Co., Cleveland, O.

A New Plan for Supporting a Hoppes Feed-Water Heater.

WITH a view to the better utilization of space, the Hoppes Manufacturing Company, of Springfield, Ohio, have designed a new method for supporting their feed water heaters which is clearly shown in the illustration. Sockets of ample size and strength are provided on the heater for receiving and holding four iron pipe columns with flanges at their lower ends for resting on the floor or foundation. This makes it possible to set the heater at any desired height and the boiler feeder or other auxiliaries may be placed under the heater and valuable space saved. The makers will furnish their cast iron or steel type of heaters with sockets and flanges when specified with the order, without additional cost to purchaser.



THE HOPPES FEED-WATER HEATER.

NEWS SUPPLEMENT

The Engineering Magazine—December, 1904

Coming Society Meetings.

AMERICAN FOREST CONGRESS. Sec.: Wm. L. Hall, Atlantic Building, Washington, D. C. Meeting under the auspices of the American Forestry Association, Jan. 2 to 6, 1905, at Washington.

AMERICAN INSTITUTE OF ARCHITECTS. Sec.: Glenn Brown, Washington, D. C. Annual convention, Dec. 15-17, at Washington.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Meetings on fourth Friday of each month at Carnegie Hall, 154 W. 57th St., New York. Subject for Dec. 23: Transmission Problems.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sec.: Prof. F. R. Hutton, 12 W. 31st St., New York. Annual meeting, Dec. 6-9, at New York.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmonstone. Regular meetings on second Monday of each month.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Sec.: D. Fleming, Harrisburg, Pa. Annual meeting, Dec. 2 and 3, at New York.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: C. H. Meeds, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec.: H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: J. O. Clarke, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: H. J. Pfeifer, 920 Rialto Bldg. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month, except July and August.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INTERNATIONAL RAILWAY CONGRESS. General Sec.: Louis Weissenbruch, Belgian State Railways, Brussels, Belgium. Sec. of American Section: W. F. Allen, 24 Park Place, New York. Seventh session, May 3-15, 1905, at Washington.

Iowa Railway Club. Sec.: P. B. Vermillion, Des Moines, Iowa. Regular meetings on third Tuesday of each month.

Louisiana Engineering Society. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

Massachusetts Street Railway Association. Sec.: Charles S. Clark, 70 Kilby St., Boston. Meetings second Wednesday of each month, except July and August.

Montana Society of Engineers. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

New England Railroad Club. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings, second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

New England Street Railway Club. Sec.: J. H. Neal, 101 Milk St., Boston. Meetings on last Thursday of each month.

New York Electrical Society. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

New York Railroad Club. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

North-West Railway Club. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

Pacific Coast Electrical Transmission Association. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

Pacific Coast Railway Club. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

Pacific Northwest Society of Engineers. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

Railway Club of Pittsburg. Sec.: J D. Conway, P. & L. E. R. R., Pittsburg, Pa Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

Railway Signal Association. Sec.: H. S. Balliet, South Bethlehem, Pa. Regular meetings on second Tuesday of January, March, May, September and November.

Railway Water Supply Association. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter, at Alexander Hall, South Minneapolis, Minn.

Richmond Railway Club. Sec.: F. O. Robinson, 8th and Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

Rocky Mountain Railway Club. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

St. Louis Railway Club. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

Society of Chemical Industry. New York Section. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, except June, July, August and September, at Chemists' Club, 108 W. 55th St.

Southern and Southwestern Railway Club. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of January, April, August and November, at Atlanta.

Technical Society of the Pacific Coast. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

Technology Club of Syracuse. Sec.: A. Frederic Witmer, 707 Dillaye Building. Meetings monthly, except in June, July, August and September.

Texas Railway Club. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

Toledo Society of Engineers. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

Western Railway Club. Sec.: J. W. Taylor, 667 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

Western Society of Engineers. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

Personal.

—Mr. Charles Lang, formerly with the Wheeler Condenser and Engineering Co., has joined the sales department of the A. D. Granger Co., at their New York office, 95 Liberty Street. Mr. Lang will make a specialty of pumps and condensers, the A. D. Granger Co. having recently acquired the agency for the Barr Pump Company, of Philadelphia.

—Mr. J. W. Duntley, president of the Chicago Pneumatic Tool Company, sailed recently on a short business trip to Europe, where he will start the new plant for the manufacture of his company's apparatus located at Fraserburgh, Scotland, and will visit the business centers of England, Scotland and the Continent in the interests of the rapidly growing foreign business of the Chicago Pneumatic Tool Company.

Mr. E. D. Grant, who for some time past has been instructor in the department of Mathematics and Physics of the Michigan College of Mines, has recently been made assistant professor in the same department.

—Mr. Edward James, who was for many years connected with the Burt Mfg. Co. and who established their filter business throughout the country, has entered the employ of the Pittsburgh Gage and Supply Co., of Pittsburgh, and will look after the interests of the latter company with regard to their White Star oil filters in all parts of the South and West.

—Mr. Ernst Wiener, of the firm of Arthur Koppel, recently returned from a three months' trip to Europe.

Industrial Notes.

—The American Society of Mechanical Engineers will hold its annual meeting in New York, from Tuesday, Dec. 6th, to Friday, Dec. 9th, inclusive. A number of interesting papers will be read, and the usual reception will be held on Thursday evening, Dec. 8th, at Sherry's. The following nominations have been made by the nominating committee: For president, John R. Freeman; for treasurer, William H. Wiley; for vice-presidents, S. M. Vauclain, H. H. Westinghouse and Fred W. Taylor; and for managers, George M. Brill, Fred J. Miller and Richard H. Rice.

—Keuffel & Esser Co., of New York, who have had such a fine exhibit of their drawing materials, mathematical and surveying instruments and other products at the Louisiana Purchase Exposition, in St. Louis, have been awarded the only grand prize in Group 19, Liberal Arts (comprising instruments of precision, philosophical apparatus, etc.) and a gold medal in Group 115, Mines and Metallurgy (comprising instruments and equipment for underground surveying).

—The Eureka Construction Co., of 287 4th Ave., New York, has entered the field of fireproof building construction under the auspices of men who have made almost a life study, not only of the manufacture of fireproofing material, but as well of its proper and efficient installation. This company purposes to confine its operations chiefly to railroad work, such as car barns, sheds, stations, warehouses, etc., having secured rights under different patents which cover methods peculiarly adapted to such work, among others, the Phœnix wall construction, and the Herculean, Eureka and Peerless systems for floor arches.

—The Thomas S. Clarkson Memorial School of Technology has been awarded a bronze medal by the International Jury in the group comprising higher education, technical schools, etc., at the Louisiana Purchase Exposition. Its exhibit was warmly commended by the members of the jury, and has been a source of interest to visitors throughout the summer.

—The American Blower Company will supply about 133,000 feet (over 25 miles) of one-inch steam pipe for the "hot-blast" heating and tempering coils to be installed in the new Wanamaker Building in Philadelphia. This pipe is being manufactured into one hundred and eleven "A B C" heater sections, varying in capacity from 3,500 to 56,000 feet of heating surface each. In connection with these heaters and in other parts of the building 28 "A B C" fans will be used, the largest of these having a housing 220 inches high and the smallest 50 inches. The completed apparatus, which is now being constructed in the American Blower Company's factory at Detroit, will make a ten-carload shipment. "A B C" apparatus is also to be installed in the New York Wanamaker Building. Some 44,000 feet of one-inch pipe will be used in the heaters and seven large fans will ventilate the building.

—Alberger condensing apparatus, manufactured by the Alberger Condenser Co., of 95 Liberty St., New York, and exhibited at the Louisiana Purchase Exposition, received a grand prize.

The Eureka Fire Hose Co., of New York, desire to state that Messrs. W. H. Salisbury & Co., who have handled the product of the Eureka Fire Hose Co. for so many years with marked success, will continue to be their only representatives at Chicago.

and it is furthermore hoped will remain indefinitely in control, thus adding to a long term of service that has been characterized by the highest degree of business tact and integrity.

—The Westinghouse Companies at the Louisiana Purchase Exposition have received the following awards from the International Jury: Special award in the Department of Machinery for "the best, most complete and most attractive installation." Twelve grand prizes: To the Westinghouse Electric and Manufacturing Company, for "alternating-current generators and motors, alternating-current turbo-generator installation, static transformers, and rotary converters"—Group 67; to the Westinghouse Electric and Manufacturing Company, for "direct current generators and motors"—Group 67; to the Westinghouse Electric and Manufacturing Company, for "electric railway motors, alternating current and direct, and control systems for single and multiple unit operation and for mining and industrial locomotives"—Group 67; to the Westinghouse Machine Company, for "horizontal gas engines and steam turbines"—Groups 62 and 63; to the Westinghouse Air Brake Company, for "air brakes and friction draft gears"—Group 74; to the Westinghouse Traction Brake Company, for "brakes for electric cars"—Group 74; to the American Brake Company, for "driver brakes"—Group 74; to the Westinghouse Automatic Air and Steam Coupler Company, for "air and steam couplers"—Group 74; to the Westinghouse Brake Company, Limited, London, England, for "air brakes and accessories"—Group 74; to the Westinghouse Company, Limited, of St. Petersburg, Russia, for "air brakes and accessories"—Group 74; to the Union Switch & Signal Company, for "signal systems"—Group 74; to the Cooper-Hewitt Electric Company, for "the development of the mercury vapor arc lamp"—Group 69. Eight gold medals: To the Westinghouse Electric and Manufacturing Company, for "complete switchboards and controlling apparatus, and the application of electric motors for mechanical purposes"—Group 67; to the Westinghouse Electric and Manufacturing Company, for "alternating current, direct current, and Bremer arc lamps and arc lighting systems"—Group 69; to the Westinghouse Electric and Manufacturing Company, for "electric measuring instruments"—Group 71; to the Nernst Lamp Company, for "Nernst lamps"—Group 69; to the Cooper-Hewitt Electric Company, for "vapor lamps for photo-engraving"—Group 15; to the Pittsburg Meter Company, for "water and gas meters"—Group 64; to the Westinghouse Electric and Manufacturing Company, for "industrial betterment work"—Group 138; to the Westinghouse Air Brake Company, for "the housing of the working classes"—Group 136. Four silver medals: To the Westinghouse Electric and Manufacturing Company, for "switches, fuses, and wiring appliances"—Group 69; to the Sawyer-Man Electric Company, for "incandescent lamps"—Group 69; to the Bryant Electric Company, for "electric-light fittings"—Group 69; to the Société Anonyme Westinghouse, Havre, France, for "gasolene automobiles"—Group 72. One bronze medal: To the Perkins Electric Switch Manufacturing Company, for "electric switches"—Group 69.

—H. B. Underwood & Co., of Philadelphia, the manufacturers of portable and other special tools and machines, have issued an attractive souvenir in the shape of a blotter pad with a picturesque celluloid cover.

—The C. W. Hunt Company, of West New Brighton, New York, have been particularly successful at the St. Louis World's Fair, two of their three exhibits securing high awards, the third not entered. The Hunt "Industrial" railway received the gold medal for narrow-gauge railways, and the electric storage-battery locomotive built by this company received the silver medal, being the highest award for this type of locomotive.

—The Ball Engine Co., of Erie, Pa., has received an order for a 1,000-horse-power horizontal cross-compound Corliss engine for the Altoona shops of the Pennsylvania railroad.

—The Goldschmidt Thermit Co., of New York, have been awarded a grand prize at the St. Louis Exposition, where they have had a working exhibit in charge of Mr. W. M. Carr. The Franklin Institute, of Philadelphia, has also distinguished Dr. Goldschmidt for his inventions by conferring on him the Elliott Cresson Medal. As is well known, this company employs its product, Thermit, consisting of specially prepared granulated or powdered aluminum, for welding rails and many other objects, repairing large broken metal parts, for producing pure iron and iron and steel alloys, and for other purposes.

—The American Cement Company, Pennsylvania Building, 15th and Chestnut Streets, Philadelphia, Pa., have been awarded the first contract for the cement for the Panama Canal, the amount being 10,000 barrels. The bid was made in the name of their New York selling agency, The United Building Material Company, Park Row Building, New York City, and the award was made last Saturday. The American Cement Company have secured for their old reliable "Giant" Portland Cement contracts on some of the most important engineering works in the world, including 1,500,000 barrels for the New York Subway.

—The Moody Publishing Co., of 35 Nassau Street, New York, have published an attractive and interesting little book, entitled "The Art of Wise Investing," which contains a series of short articles on investment values, pointing out the essential characteristics of safe investment securities, with a review of the financial pitfalls into which superficial examination inevitably leads.

—Allis-Chalmers Company has won high honors at the St. Louis Exhibition with each of their three exhibits:—steam engine, electrical, and mining. The five-thousand-horse-power engine popularly known as the "Big Reliable," and the huge generator built by this company's electrical department, otherwise known as the Bullock Electric Manufacturing Company, each won a grand prize. These two machines, forming the huge unit which supplies the world-famous decorative lighting of the Exposition buildings and grounds, and which have never failed under the most frequent and most unexpected emergency loads, are so well known that it is unnecessary to describe them again. In the Department of Mines and Metallurgy the Allis-Chalmers exhibit was also awarded a grand prize, the highest honor given by the International Jurors. Among other features of this mining exhibit and contributing to the success which won the highest award, are the famous style "K" Gates gyratory rock and ore breakers, the Overstrom concentrating table, the Allis-Chalmers style "A" and "B" crushing rolls, the Gates ball and tube mills, and the heavy six-foot Huntington mill, known as the "Anaconda" type, manufactured only by this company. The Bullock Electric Mfg. Company's grand prize also covered all their alternators, synchronous motors, direct-current generators and motors, and rotary converters. This award, in competition with their older and greater competitors, is a significant tribute which must interest all users of electrical machinery. In addition to all this, the Bullock system of multiple-voltage control of motors won a gold medal.

—Morse chains, made by the Morse Chain Co., of Trumansburg, N. Y., have been installed in the Vulcanized Rubber Company's works at Morrisville, Pa., for transmitting power from the engine to lines of shafting, and from about forty electric motors to individual tools, blowers and pumps. In a statement by Mr. George Hill, consulting engineer, of New York, who installed this plant, he describes the exacting requirements, speaks of the successful operation of the Morse chains in driving the shafting from the engine, and the saving in space due to their use, and in conclusion says: "The cost of the individual drives from the motor was much more than for leather belting, but the Morse chain has a most decided advantage on account of the positive speed ratio obtained, less space required, higher efficiency and greater durability, making it the more desirable transmission to use. Loss of time repairing belts is a considerable item each year, that costs in the delivery of an order frequently far more than the chains cost. The efficiency claimed by the makers was practically 99 per cent., and on the large speed ratios used I could hardly expect to obtain an efficiency of over 94 per cent. by the use of belting. This difference in efficiency between the two methods of transmission would, if the chain were as durable as claimed, save enough in the power cost alone to renew the chain when worn out. While not enough time has elapsed to substantiate all the claims made by the makers, careful inspection of the chains running show them to be giving perfect service, and this has persuaded me to use the Morse chain for other contracts, as commercially they are the cheapest to use if a period of five or more years is considered."

—The Laidlaw-Dunn-Gordon Company, of Cincinnati, who installed the two large air compressors located in Block 33 of Machinery Building, have been awarded a grand prize by the Louisiana Purchase Exposition for their improvements in valve mechanism. One of the machines has a capacity of 1,300 cubic feet of free air per minute when running at 125 revolutions, and is used to supply the general compressed-air requirements of the Exposition, while the other is capable of furnishing 530 cubic feet and supplies the transportation exhibits. The large machine is fitted with an improved type of valve gear, the distinguishing feature of which is the novel manner of using poppet valves for controlling the opening of the discharge in combination with the semi-rotary, mechanically moved valves for controlling the closing of the discharge and the opening and closing of the suction.

—The Electric Controller and Supply Company, of Cleveland, O., have been awarded a gold medal for their St. Louis World's Fair exhibit. The apparatus shown consists of a full line of their regular controllers for crane, charging machine and similar service; a working exhibit of a magnetic switch controller built for motors of any horse power; magnetic friction and stop brakes; cushion-type solenoids; electric lifting magnets for plates, billets, etc.; resistance banks; knife switches; and a working exhibit of their direct-connected variable-speed motor drive for planers.

—The Eureka Fire Hose Co., of New York, announce that their "Eureka," "Paragon" and "Red Cross' brands of seamless rubber-lined fire hose have been awarded a gold medal at the St. Louis World's Fair. It was to be expected that the product of the Eureka Fire Hose Co. would receive such substantial compliment, as their fire hose is a recognized necessity in every fire department where reliability is considered paramount to every other consideration.

—The Walworth Manufacturing Co., of Boston, have been awarded a gold medal at the St. Louis Exposition for their exhibit of valves, brass and iron goods, pipe fittings, and engineers', gas and steam fitters' tools.

The Derry-Collard Company, of 256-257 Broadway, New York, have published a "Tractive Power Chart" for finding the drawbar pull of locomotives without making any calculation. This chart is printed on a sheet of tough paper about 15 by 20 inches in size. It gives the cylinder diameter, area and volume for all diameters between 15 and 34 inches, and strokes between 20 and 36 inches, and includes boiler pressures between 120 and 230 pounds, and driving-wheel diameters from 28 to 90 inches. It not only shows the drawbar pull when these data are given, but it can be worked backwards to determine what sized engine must be used to get a certain drawbar pull. This chart will be found very useful, and can be obtained by sending 50 cents to the publishers.

—The Jury of Awards of the Louisiana Purchase Exposition has awarded a gold medal for rail fastenings to the Continuous Rail Joint Company of America, for their display made in the Transportation Building. The exhibit shows various types of rail joints produced by patented machinery controlled by the company in this country. The careful manufacture and perfect fit, giving three points of contact in one piece of metal, thus forming a rail joint of two symmetrical pieces, obtained as a result of these patents, have secured for them both from steam and electric railroads an appreciation which is shown by the fact that over 20,000 miles of railroad track have been equipped with the continuous rail joint during the past ten years. The company owns and operates the Albany Iron & Steel Works at Troy, N. Y. They have on the market to-day types of joints for tee rails and girder rails that are made of rolled steel. They also manufacture step, or compromise joints, to connect rails of different sections, and obtain a perfect surface and gauge for abutting rails. These are made of cast steel. This company is now bringing out a new type of insulated rail joint, and also an electric bonding joint to be placed upon the market. These appliances have already been introduced in many foreign countries. The general offices of the company have always been at Newark, N. J.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue No. 53, entitled "Modern Practice in Air Compression," containing descriptions of Sullivan air compressors, and a great deal of useful and interesting information regarding compressed air and its various applications, with many handsome illustrations and an index. 9 by 6 in.; pp. 127. Sullivan Machinery Co., Railway Exchange, Chicago.

Alternators.

Bulletin No. 3, containing illustrations and descriptions of alternating-current generators direct connected to De Laval steam turbines by means of flexible couplings, with tables of dimensions. 9 by 6 in.; pp. 24. De Laval Steam Turbine Co., Trenton, N. J.

Carriers.

Pamphlet entitled "Mechanical Messengers," containing half-tone illustrations and descriptions of Lamson pick-up and delivery carriers, which afford an automatic and rapid means of transporting messages, packages, books, and other articles in offices, stores, factories, libraries and other establishments. 11¾ by 9 in.; pp. 16. Lamson Consolidated Store Service Company, Boston, Mass.

Cement Sidewalk.

Pamphlet entitled "Suggestions as to the Method of Construction of Cement Sidewalk Paving," compiled by Albert Moyer, and containing specifications for "granolithic cement concrete" or "artificial stone" sidewalks and pavements, with some typical views. 9 by 6 in.; pp. 12. Vulcanite Portland Cement Co., Flatiron Building, New York.

Centrifugal Pumps.

Pamphlet devoted to high-grade centrifugal pumping machinery, with illustrations of a few representative designs, a glossary of terms and other useful data and tables. 11 by 8½ in.; pp. 16. R. D. Wood & Co., Philadelphia.

Chains.

Catalogue No. 185, entitled "Forgings and Castings," containing illustrations and descriptions of the "Warwick" and the "Trident" chains for ships' cables, dredges, steam shovels, conveyors, loading, mining, quarrying, rafting and other uses, and also shackles, swivels, rafting dogs, bolts, davits, cleats and other appliances for marine, towing and conveying work. 9 by 6 in.; pp. 32. Newhall Chain Forge & Iron Co., 9-15 Murray St., New York.

Channeler.

Form 322, a pamphlet with illustrations and descriptions of the "Broncho" channeler, a light, handy machine for cutting channels in rock, and for doing other work in quarries and rock excavations. 9 by 6 in.; pp. 15. The Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

Chimneys.

Pamphlet, containing illustrations and descriptions of the Weber system of constructing chimneys of concrete, reinforced by vertical T steel bars, encircled by steel rings, and connected by sheet-iron clamps, together with views of some large completed chimneys. 9 by 4 in.; pp. 31. Weber Steel-Concrete Chimney Co., Ashland Block, Chicago.

Condensers.

Catalogue No. 4, containing half-tone illustrations and descriptions of Alberger barometric condensers and their auxiliary apparatus, central condensers, single and two-stage dry vacuum pumps, Corliss circulating pumps, centrifugal circulating pumps, series-multiple centrifugal pumps, cooling towers, exhaust relief valves and entrainers, and other high-grade condensing apparatus. 9 by 6 in.; pp. 48. Alberger Condenser Company, 95 Liberty St., New York.

Cooling Towers.

Pamphlet, containing illustrations and descriptions of Stocker's patent cooling towers for cooling the water from condensers in steam plants, ice factories and other plants, with an interesting account of the advantages and economy of cooling towers. 8½ by 6 in.; pp. 36. George J. Stocker, St. Louis.

Coupling.

Circular, containing illustrations and description of the Almond patent coupling, a counter shaft for transmitting motion at right angles in a noiseless and very efficient manner. 12 by 9 in.; pp. 4. Also, circulars and folders devoted to the Almond turret-head tool drill chucks, flexible steel tube for conveying oil or gas, and for electric and gas brackets, and other specialties. T. R. Almond Manufacturing Co., 83 and 85 Washington St., Brooklyn, N. Y.

Dry Kilns.

Illustrated sectional catalogue No. 166, devoted to the "A B C" dry kilns for timber products. It contains descriptions of moist air dry kilns, blower dry kilns, hot blast apparatus and all kinds of dry kiln appurtenances, with remarks on the theory of kiln lumber drying, and views of kiln plants in various parts of the world. 8¾ by 7 in.; pp. 78. American Blower Co., Detroit.

Electric Apparatus.

Binder containing many bulletins devoted to arc lamps, electric generators, electric motors, motor-starting rheostats, wattmeters, voltmeters, ammeters, switchboards, cut-outs, transformers, street-lighting systems, and other electric machinery and apparatus, with many illustrations. Also, index to bulletins. 10½ by 8 in. Fort Wayne Electric Works, Fort Wayne, Ind.

Electric Driving.

Bulletin No. 221, devoted to "Direct-Current Motor Equipments for Printing Presses and Allied Machines," and containing descriptions and many illustrations of electric motors, controllers, resistances, and other apparatus and their application to machinery in printing, engraving and stereotyping plants. 10½ by 8 in.; pp. 48. Sprague Electric Company, 527-531 W. 34th St., New York.

Electric Switches.

Bulletin No. 6010, devoted to "Knife Switches." It contains illustrations, descriptions, prices, tables of dimensions and other data concerning various types and sizes of knife switcnes and other electric switchboard apparatus and fixtures. 10¾ by 7¾ in.; pp. 38. Western Electric Company, 259 South Clinton St., Chicago.

Elevator Machinery.

Catalogue D, devoted to elevator machinery and power transmission appliances. It contains illustrations, descriptions and price lists of pulleys, sheaves, hand wheels, tension carriages, gears, couplings, hanger, belt tighteners, rollers, sprocket wheels, and many other appliances for elevating and conveying work and for shafting and belting. Also, index. 7½ by 5½ in.; pp. 212. Minneapolis Steel and Machinery Co., Minneapolis.

Feed-Pump Controller.

Pamphlet, with illustrated description and price list of Mullin's automatic controller for boiler feed pumps, and directions for connecting and operating it. 9 by 6 in.; pp. 4. Also, pamphlet devoted to Mullin's duplex-automatic regulator and mixer for fuel oil. 9 by 6 in.; pp. 4. The Federal Valve Co., Seattle, Wash.

Gauges.

Catalogue for 1904, containing illustrations, descriptions and prices of high-grade pressure and vacuum gauges of the self-contained type for all purposes, marine clocks, tachometers, watchman's portable control watches, steam-engine indicators, testing pumps, mercury gauges and thermometers, water gauges, safety valves, and many other fittings and appliances. 10 by 6½ in.; pp. 106. Standard Gauge Mfg. Co., Syracuse, N. Y.

Graphite.

Pamphlet giving the important facts, together with the prices, of Dixon's lubricating graphites and graphite lubricants, with illustrations and an ornamental cover. 8½ by 5½ in.; pp. 28. Also, illustrated pamphlet, showing the benefits derived from the use of graphite for lubrication on automobiles and motor boats. 7¾ by 5¼ in.; pp. 21. Joseph Dixon Crucible Co., Jersey City, N. J.

Lava.

Pamphlet entitled "Lava for Mechanical and Electrical Purposes," containing illustrations and descriptions of gas tips and burners, electrical insulators and other objects made of the mineral talc, which is machined in its natural condition and then baked at a high temperature to a condition of extreme hardness. 9 by 6 in.; pp. 12. American Lava Company, Chattanooga, Tenn.

Magnetic Switches.

Bulletin No. 1010, with descriptions and illustrations of magnetically operated switches for electric circuits, of the gravity type and the clapper type; and Bulletin No. 1004, devoted to solenoids and electromagnets of the "magnetic-cushion" type, in which there is no blow or shock when the plunger is brought to rest at the end of its travel. 6¾ by 5 in.; pp. 8. The Electric Controller and Supply Co., Cleveland, O.

Power Station.

Handsome pamphlet, entitled "The Power of the New York Subway," with ornamental cover and half-tone illustrations, devoted particularly to the large Allis-Chalmers steam engines in the great power station of the Interborough Rapid Transit Company, and with a general description of the Subway itself. 10¼ by 8 in.; pp. 19. Allis-Chalmers Company, Milwaukee.

Producer Gas.

Catalogue A, section 1, dealing with producer gas for power and fuel, its uses and cost, and containing illustrations of gas producers, a general discussion of producer gas, and comparison of producer gas with other sources of power. 9 by 6 in.; pp. 15. Wile Power Gas Co., Rochester, N. Y.

Pumps.

Illustrated pamphlet, containing descriptions of some of the characteristic Cameron designs of steam pumps, including sinking pumps, feed pumps and other regular and special types, with tables of prices, dimensions and weights. 5¾ by 3¼ in.; pp. 52. A. S. Cameron Steam Pump Works, Foot of East 23d St., New York.

Steam Head.

Bulletin L-602, illustrating and describing a special steam head for operating deep-well pumps, where it is necessary to place the pump cylinder far below the steam cylinder. 9 by 6 in.; pp. 4. Laidlaw-Dunn-Gordon Co., 114-118 Liberty St., New York.

Steam Shovels.

Catalogue No. 4, containing half-tone illustrations, descriptions and tables of principal dimensions of steam shovels and excavators for mines, smelters, blast furnaces, ore docks, brickyards, cement works, railroads and contractors. Shovels equipped with electric motors are shown, and dipper dredges also are illustrated. 6 by 9 in.; pp. 32. The Thew Automatic Shovel Co., Lorain, O.

Well Machinery.

Manufacturers' catalogue, illustrating and describing a full line of well sinking and prospecting machinery, artesian-well and compressed-air pumping machinery, air compressors, gasoline and steam engines, boilers and many tools and appliances for well sinking by the most modern methods, with code words and prices. 9 by 6 in.; pp. 160. The American Well Works, Aurora, Ill.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

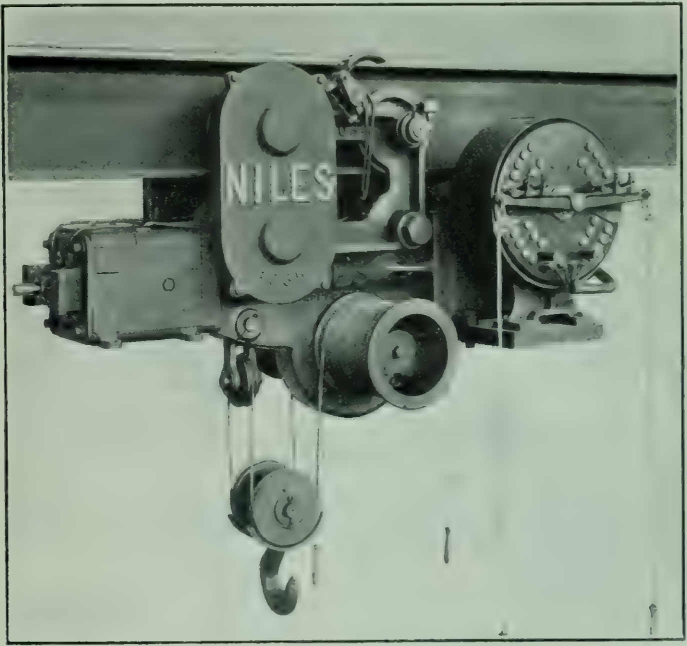
Electric Traveling Hoists.

ELECTRIC traveling hoists are rapidly coming into favor, and many of the more progressive shops are installing them in place of hand hoists.

Besides the direct advantage of handling loads vastly quicker than the hand hoist, the electric traveling hoist has the indirect advantage of increasing the output of a shop by waking up the men. The hoist moves so rapidly that it compels the workmen to be quick in their movements, and instinctively they do their regular work more quickly. On the other hand, if the workman is using a hand hoist, he is pretty well tired out after he has lifted a load, and does not return to his regular work with much vigor.

The illustration shows a new type of Niles hoist built in capacities of 3/4 to 6 tons, that may be used either as hoists, in which case they run on an I-beam track, or when mounted on a traveling bridge they may be used for small capacity cranes. In the latter case they are arranged to run between the two I beams or channels of the bridge, and the controllers for raising and lowering the hook and operating the traversing mechanism may be placed either on the hoist, on the bridge and operated by cords from the floor, or in an operator's cage attached to the bridge.

When used on an I beam, the controllers are attached to the hoist and operated by cords from the floor. These hoists will run on straight and curved tracks and are usu-



NILES ELECTRIC TRAVELING HOIST.

ally provided with a separate motor for traversing, but if desired, hand traverse may be furnished, or all the traversing mechanism may be omitted and the trolley moved along the track by pushing on the load. The increased service of the electric traverse, however, much more than compensates for the slight additional cost.

The hoist is self-contained in one heavy cast-iron frame to which the motors are attached end on, and the power is transmitted directly from the armature shaft to the drum shaft through one train of worm and worm-wheel gears.

The traversing mechanism is also driven through one train of worm and worm-wheel gears similar to the hoisting mechanism, except that when the trolley is arranged to run on a single I-beam, a double set of transmission gears is used to connect the worm-gear shaft to the truck-wheel shafts. All the mechanism is enclosed in oil- and dust-proof casings and is absolutely noiseless in operation.

In addition to the braking effect obtained by the use of the worm and worm wheel, a powerful electric brake is attached to the hoist motor.

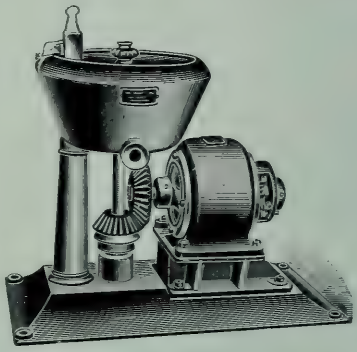
Further information regarding these hoists may be obtained from the builders, Niles-Bement-Pond Company, 136-138 Liberty Street, New York.

Electrically Driven Centrifugal Oil Separator.

AN electrically driven centrifugal oil separator, with which motors for any voltage can be furnished, is shown in the accompanying illustration. This apparatus is especially designed for use in machine shops and similar establishments, to separate the oil from chips, turnings or cuttings of any kind, and from small work of all kinds that is made on screw or other machines, where oil is used in the operation.

With this machine oil can be separated and used again almost indefinitely, there being, of course, some waste, but little in comparison with that where no separator is employed. The large amount of oil annually wasted is a strong argument in favor of the use of such a machine.

These oil separators are well made, compact and durable. The spindle quill, or step, is positioned between rubber springs, and all these parts are held in a casing in the base of the machine by a screw gland, so that the proper operation can be obtained by varying the tension of this gland. An inner pan, with bronze sleeve surrounding the spindle is provided, having a capacity of 750 cubic inches, this pan being removed to empty the contents after the oil is extracted, which ordinarily takes from 5 to 8 minutes.



CENTRIFUGAL OIL SEPARATOR.

The weight of the machine shown is 525 pounds, and it has a speed of 1,800 revolutions a minute. Further particulars will be cheerfully furnished by the American Tool & Machine Co., of 109 Beach St., Boston, or upon application to their New York office, 220 Broadway.

Stocker Cooling Tower.

THE cooling tower, built by George J. Stocker, of St. Louis, has attracted a very considerable share of attention on account of the superior results obtained by it. A degree of perfection has been attained in the manufacture of this apparatus by the skilful arrangement of all its parts, which makes it to-day one of the best and most efficient water-cooling devices on the market.

Of the principles underlying its operation evaporation is by far the most important, although the cooling process is incidentally assisted by two other agencies, radiation and the contact of cold air.

The accompanying illustration shows the general arrangement of the apparatus. It consists of a tower-like structure (built of wood, steel or bricks, as circumstances may require), encasing the cooling surfaces, which are made up of checker work or cross pieces of boards in horizontal layers, set at right angles to each other and provided, between their intersections, with upright oblique partitions.

The water, led to the top of the tower, trickles down over these surfaces in a thin film, which is broken up at each intersection of the boards and thus brought in the most intimate contact with the current of air that is forced by two fans through the tower.

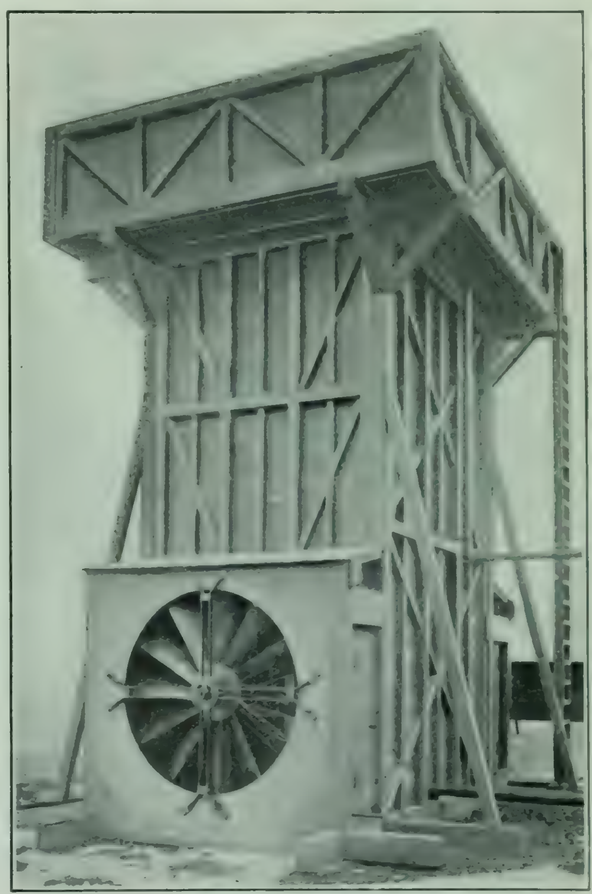
The fans, mounted on one shaft, may be driven by any convenient source of power, from a line shaft or by a small steam engine or electric motor, directly connected to the fan shaft.

The contrivance by which the water is distributed over the tower, and which was patented in March, 1902, consists of a system of funnel-shaped troughs of galvanized iron, so constructed and arranged that the water flows in an evenly proportioned way over the cooling surfaces, be the load great or small. The troughs are not liable to be clogged by sediments of impure water, as perforated pipes used in other towers always are, and can be cleaned easily.

A gallery, or drip hood, surrounds the tower, serving the double purpose of making the water distributor accessible to inspection and cleaning, and of preventing the water from splashing over the tower.

The superiority of the Stocker cooling tower lies first, in the improved construction of the cooling surface; second, in the unique method of distributing the water over the tower; third, in the application of two fans, instead of only one; and fourth, in the judicious selection of the materials from which all its working parts are built.

By this means the physical laws on which the cooling of liquids rests are brought into fullest play, and the water is consequently cooled to the lowest temperature compatible with the hygroscopic condition of the atmosphere, and at smaller cost per gallon than with any other cooling tower.



STOCKER COOLING TOWER.

Concerns who are users of large quantities of water for condensing and cooling purposes, cannot but be interested in the device, which saves from 95 to 98 per cent. of the water, by bringing it back to a physical condition and temperature where it can be used over and over again, and they may obtain full information about this cooling tower by applying to the manufacturer, George J. Stocker, of 2833 South Kingshighway Boulevard, St. Louis

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The Cockerill Gas Engine.

AMONG the first large gas engines to be put into commercial service were those of the Cockerill Company, at Seraing, Belgium, which were so successfully operated with gas from the blast furnaces there that they have been extensively adopted throughout Europe, and have been installed in units of from 200 to 3,000 horse power.

COCKERILL GAS ENGINE.

This engine is especially adapted for blast-furnace blowing-engine service and for heavy-duty electric light and power work. It embodies valuable distinctive features, and is thoroughly representative of the most advanced practice in gas-engine construction. It is of the well-known four-cycle type, and is constructed with one, two or four cylinders—either single, tandem, twin or twin tandem.

The valve-gear is actuated by a second-motion shaft, driven by gearing from the crank shaft and running at half the speed of the latter. The second-motion shaft is located parallel to the axis of the engine, and carries the cams or eccentrics which operate the valves. The inlet valves are situated on the top and the outlet valves on the bottom of the cylinder, and are so designed as to secure easy accessibility.

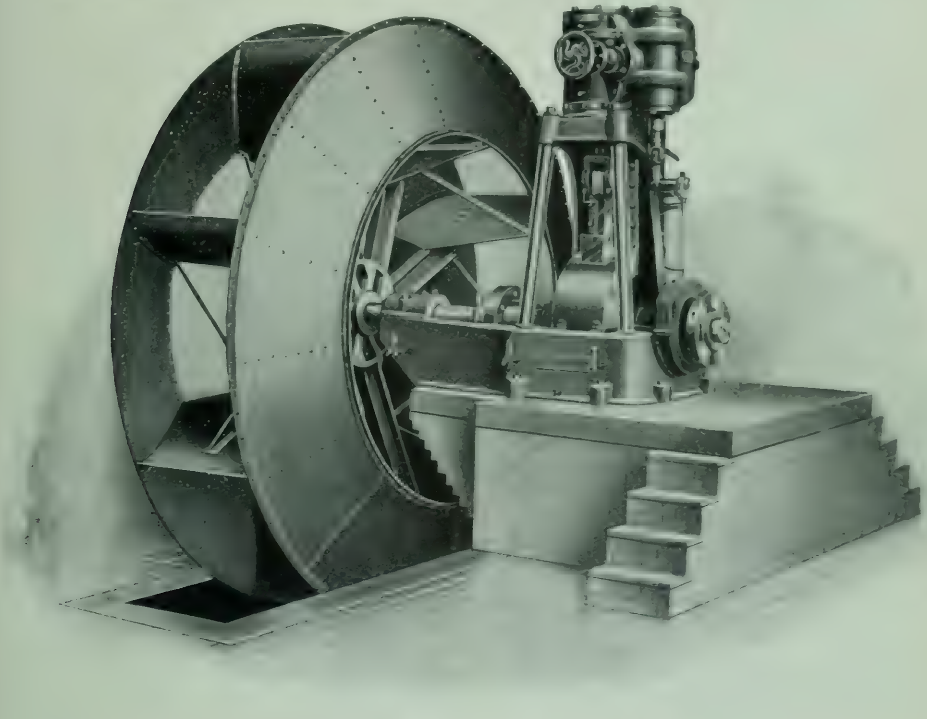
The regulation is effected by a governor which controls the admission of the mixture of gas and air in either of the following ways: First, by automatically cutting off or by throttling a constant mixture, either of which produces variable compression. Second, by varying the relative volumes of air and mixture, the latter always following the former, this method resulting in constant compression. In the latter case the mixing valve remains lifted during the entire suction stroke. The gas valve opens at a certain point during the suction stroke and remains open until near the end of the stroke. The point of opening is variable, and is determined by the governor at all times; the quantity of gas admitted is in exact proportion to the load of the engine, and the compression remains constant.

The engines are constructed with special regard to the heavy duty which they perform, and only first-class material is used. Provision is made for free expansion of the cylinder liners, and the cylinder heads can be easily removed in order to inspect the pistons without dismantling any part of the valve gear. Magneto-electric igniters of the most improved system are provided, and the starting of the engine is effected by compressed air.

A heat consumption of 10,000 British thermal units per hour per brake horse power, or a thermal efficiency of 25 per cent. at the rated capacity of the engine, is guaranteed by the sole American licensees, the Wellman-Seaver-Morgan Company, of Cleveland, who will be glad to furnish further details on application.

Mechanical-Draft Apparatus.

THE application of fans to induced-draft work has made necessary many changes from the established standards of fan builders, in order to avoid difficulties never met with in other lines of fan work, and even hardly anticipated in this. Most of the fans on the market to-day are built with two or three spiders, except in the very small sizes. A fan of the standard type usually has a bearing on each side of the fan, making the distance between bearings comparatively short. With this arrangement there is no deflection of the shaft, and the fan wheel is very smooth running. But when these fans have to be adapted to the handling of hot gases, it is positively necessary to keep the bearings removed from the path in which the gases travel, as they would otherwise become overheated. This necessitates either having an overhung wheel or placing one bearing outside of the inlet chamber built onto the side of the fan. Unless the bearings are placed very close to the center of the fan, the overhang will cause deflection, which will work the keys loose and most likely cause the fan wheel to strike the housing. The same is in a large measure true when the two bearings are far apart. Increasing the diameter of the shaft is not a relief, as by its own weight it will deflect. Then again, the intense heat within the housing causes it to expand, and as the steel frame work of the housing is outside and at a much lower temperature than the shell, the natural curvature, if any, is inward. Just how much this expansion will amount to can never be predetermined. Hence, the greatest of care in setting up will often prove of no value when the fan is put into operation, the deflections and expansions causing the wheel to strike on one or the other of the sides or at certain points.



A B C FAN WHEEL AND VERTICAL ENGINE.

These are matters for very serious consideration with any one who has had experience in this line of work, and the American Blower Company have devoted a great deal of time to the improvement of these details. In the wheels of their latest type of construction, a number of which are in operation and giving entire satisfaction, the spider is made up of I beams, which have about three times the strength of a double set of tee arms as usually employed. In addition to this, every blade is braced with bar iron braces from the outer rim to the center, which completely overcomes any tendency to twisting. In the side of the fan housing is built a very deep cone which reaches in close to the hub. A special arm of very heavy construction is built on the cantilever principle to carry the inner bearing, which is water jacketed. This is placed at the very apex of the cone. The distance from the end of the apex to the end of the projecting shaft seldom exceeds a foot.

The illustration shows a fan wheel mounted on a shaft with a direct coupled engine erected on this form of construction. It is not always customary to make an extension of the base of the engine as here shown. In some cases an I-beam grillage is built into the brick foundation, the engine being set on top of the outer ends of these I beams and anchored down, which makes practically a complete unit of the entire outfit.

Two large units of the character shown in the illustration have been furnished the Wilkes-Barre & Wyoming Valley Traction Co., of Wilkes-Barre, Pa. These wheels are encased in a three-quarter steel plate housing, the wheels being 11 feet in diameter and driven by 12 by 10-inch vertical engines. They are intended to furnish induced draft in the power house in the above railway plant.

Further details will be furnished on request by the American Blower Company, of Detroit.

Fire Protection in a Department Store.

THE value of private fire apparatus for the protection of individual buildings and adjoining property was thoroughly demonstrated in the Baltimore and Toronto fires, and, in fact, the Baltimore Fire Department admits that many buildings on the immediate margin of the devastated tract were saved only by the effective work of private apparatus. These buildings were supplied with either stand pipes or pumps connected with wet-pipe interior sprinklers and dry-pipe sprinklers for protection from outside fires, storage tanks holding from 1,500 to 15,000 gallons being placed on the roofs. Besides saving the buildings in which they were located these equipments stopped the advance of the fire, and undoubtedly many more buildings would have been destroyed in the absence of their efficient service. The buildings and contents protected by private apparatus in Baltimore were valued at five million dollars and at Toronto the saving from private protection was similar in extent.

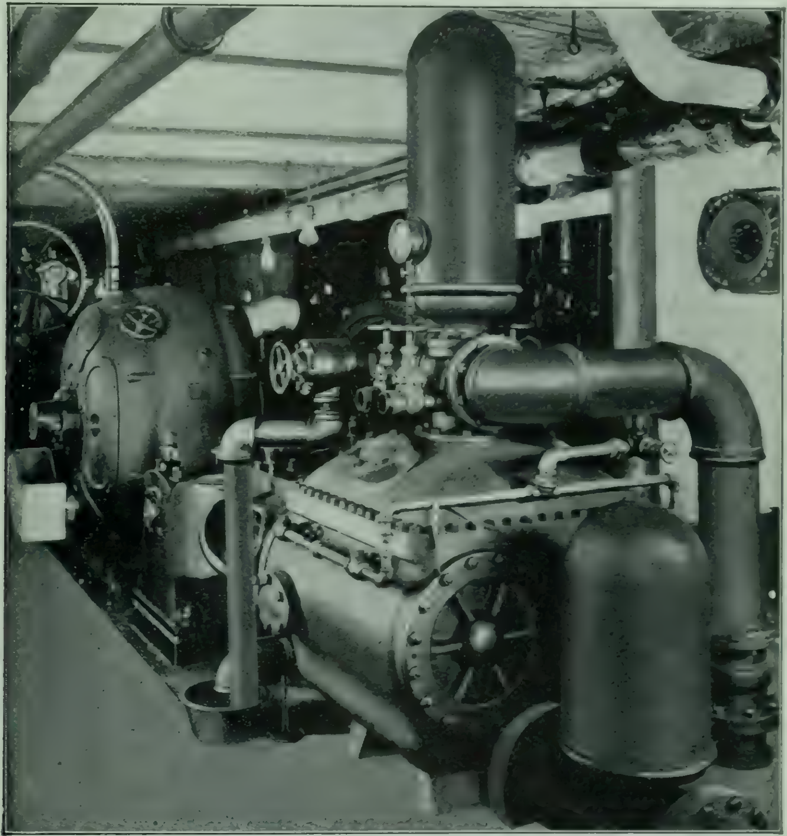
The fact that such apparatus is on the ground, in position and ready for action, averts the destruction of much property by both fire and water. A fire is usually well under way before the city fire companies can arrive, arrange their hose lines and make necessary couplings and connections. A drenching of the entire building is then often required, while a comparatively small amount of water would have put out the fire in the first place. The immediate availability of private fire apparatus gives it a great advantage over any other form. The fire insurance companies have recognized the decrease of fire risk in property containing private protection, and consequently are able to reduce premiums by such a percentage that the property owner is in a short time fully recompensed for the cost of the installation. The disastrous conflagrations of the past year have stimulated interest in the development of fire apparatus, and a very extended adoption of private equipment is to be expected.

A recent installation of considerable interest is shown in the accompanying illustration. It is located in one of the largest buildings of its class in the world, Marshall Field's immense department store, occupying an entire block in the busiest section of Chicago.

The outfit consists of a Laidlaw-Dunn-Gordon duplex underwriter pump connected by single-reduction gearing to a water-proof electric motor. The pump cylinders are eight inches in diameter by twelve inches stroke, having a theoretical capacity of 700 gallons per minute at 600 revolutions per minute against a water pressure of 140 pounds per square inch. The illustration gives a good general idea of the pump, showing the special attachments and the large pressure and vacuum chambers required by the underwriters' specifications. The pump is thoroughly rust proof in all moving or wearing parts, insuring prompt and smooth running when occasion arises.

The motor, which was furnished by the Chicago Edison Co., is shunt wound for 220 revolutions per minute at 230 volts, and is enclosed, all connections being carried through pipes screwed into the frame, so that the apparatus may be flooded without affecting its action. The fields and armature coils are cooled by fans on the armature shaft, the ventilator intake and outlet being visible in the illustration. This combination has been designed to insure reliability and certainty of action under all conditions.

One of the important considerations affecting the selection of a device of this sort is the readiness with which electric power can be obtained and utilized; but there is hardly a building where a reliable supply of electric current cannot be cheaply and easily procured, and electric driving entails no stand-by or maintenance expense as with steam apparatus.



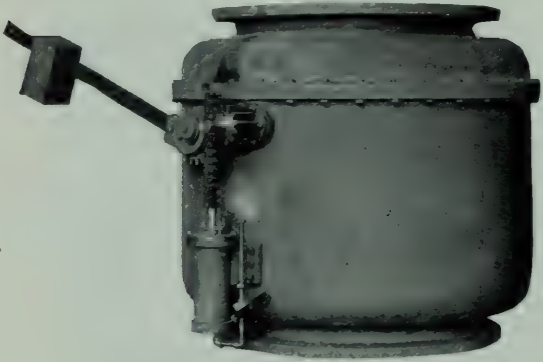
LAIDLAW-DUNN-GORDON PUMP WITH ELECTRIC DRIVE.

Further particulars regarding this interesting installation may be obtained from the International Steam Pump Co., of 114-118 Liberty Street, New York.

Large Back-Pressure Valve.

WHAT is probably the largest valve of its type that was ever constructed has recently been made by the G. M. Davis Regulator Company, of Chicago, and is to be installed at the Donora Works of the Carnegie Steel Company, Donora, Pa.

It is for a 46-inch pipe and weighs complete 7,900 pounds. It will be placed at the end of an exhaust line in a vertical position about 18 feet above the level of the floor. This exhaust line, into which five large condensing blowing engines exhaust, is approximately 215 feet in length and is gradually increased in diameter at different intervals from 28 inches at the beginning to 46 inches at the end. The low-pressure cylinders of the engines work under vacuum, and the object of the valve is to automatically provide a free relief to the atmosphere, if for any reason the vacuum is lost. If such provision were not made there would be danger of damaging the engines by the accumulation of back pressure.



DAVIS BACK-PRESSURE VALVE.

The valve body is of cast iron. The inner disc, which is guided at the top and bottom by spiders cast in the body, is of cast steel. It is faced with babbitt metal and seats on a cast-iron seat. A 2½-inch cold-rolled steel shaft runs horizontally through the body of the valve on which there are two cut steel pinions, one of which is inside the body and meshes with a cast-steel rack on the disc stem. The other is at the end of the shaft just outside the body and meshes with a rack which leads to the hydraulic cylinder, and also with the segment to which is attached the lever carrying a cast-iron counterweight of 150 pounds. The valve is provided with this counterweight to act as a safeguard by throwing the disc wide open as soon as pressure accumulates under it, thus preventing any injury to the seat by pounding. On account of the unusual size of the valve and the weight of the disc, it was found not practical to make the valve wholly automatic. It opens automatically, but the closing is controlled by hydraulic pressure, a hydraulic cylinder 5 inches in diameter being connected at the top and bottom by a ½-inch pipe on which there is a four-way cock. This cylinder is under a constant pressure of 25 pounds, and when the valve is closed the cock is set to turn the pressure into the lower end of the cylinder. When it is desired to close the valve after it has been thrown open, this cock is set to turn the pressure into the upper end of the cylinder. A gradual closing is thus effected and the cock is again set at normal position.

With the order for this valve was one for a 36-inch valve to be installed at the same works of the Carnegie Steel Company. The weight of the latter valve complete is 4,900 pounds.

Further particulars regarding these valves may be obtained from the G. M. Davis Regulator Co., of 141 Milwaukee Avenue, Chicago.

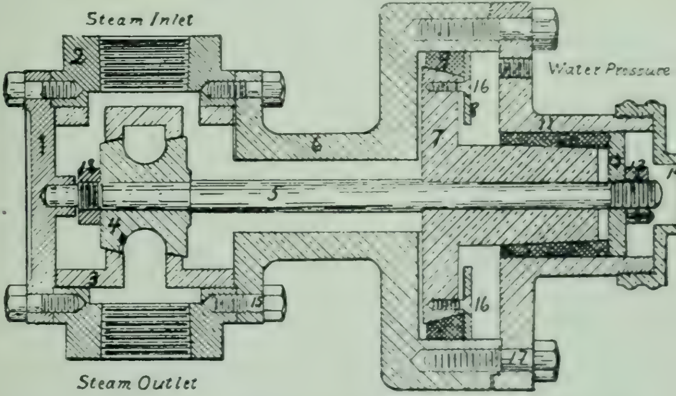
Feed-Pump Controller.

ONE of the most vital parts of a steam-generating plant is the feed pump, and it is of the greatest importance that this should operate properly and keep the boiler supplied with the right amount of water. It was formerly the custom to regulate the throttle valve of the feed pump by hand, but modern conditions demand a more efficient method, which is supplied by the apparatus shown in the illustration, Mullin's automatic controller for boiler feed pumps.

This is a governing valve controlled by the relative pressure of the steam and the water. By putting the steam pressure on one face and the water pressure on the reduced area of the opposite face, a water pressure in excess of the steam pressure is maintained, without regard to fluctuations of the steam. When the steam pressure falls, the controller, by reducing the supply of steam to the pump, reduces the feed-water pressure; and when the boiler pressure rises, there is such an additional steam delivery to the pump as will afford the requisite increase of the water pressure, thus automatically maintaining the water and steam pressures in proper ratio to each other.

Because of the large area of the piston of the controller exposed to pressure, it is extremely sensitive and will respond to the slightest variations of pressure, delivering more water to the boilers when the steam pressure is high and less when it is low, which not only holds the water uniform, but also tends to keep the steam pressure uniform, thus saving fuel that is wasted in pumping too fast and flooding the boilers when the fires are low.

No relief valve is necessary where the controller is used, as the pump will stop when the proper pressure has been reached and will start again automatically when required, so saving excessive wear on the pump incident to discharging through the relief valve at high restrained pressures. It is not necessary to throttle the pump every time a feed valve is changed, as after that valve is opened wide when the plant is started up, it is so left while the plant is running. In this way the hand regulation of the feed valves on the boilers is reduced 85 per cent. and the time and trouble of traveling from feed valve to pump many times a day is saved. In a battery of boilers this is particularly desirable during the cleaning of fires, as the hand regulation of the feed valves does not affect the feed of those already set, and the feed can be taken all off, without going near the pump.



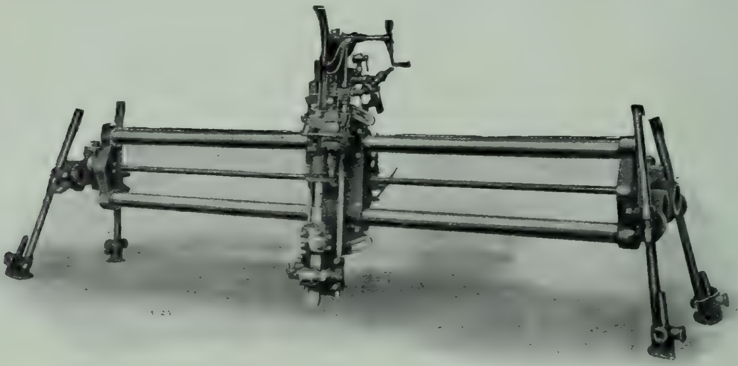
MULLIN'S AUTOMATIC CONTROLLER FOR FEED PUMPS.

The Mullin automatic feed-pump controller is constructed of good material and is supplied in pipe sizes from one-half inch up. The valve seats are of phosphor bronze and will not cut out by steam action. This controller has no arms, weights, springs, floats or any other contrivances to get out of order and give trouble, and further information concerning it and its operation may be obtained from the manufacturers, The Federal Valve Co., of Seattle, Wash.

Ingersoll-Sergeant "Broncho" Channeler.

IN the quarry processes of to-day, there is a wide field of usefulness for a rock-cutting machine intermediate in its functions between the heavy track channeling machine and the machine drill as applied in the "plug and feather" method of breaking rock. In the development of new quarrying properties, also, it is advisable to prove up the value of the deposit before heavy investments are made. Yet the slow method of hand clearing and prospecting cannot be tolerated. In developed quarries, too, it is often necessary to channel material which has a sharp dip or incline, and there a heavy track channeler is not practicable. In the lighter work of the quarry, such as cutting stumps and keyblocks, enlarging the walls and working in confined and uneven places, a light portable machine is always useful and effective.

To meet just such conditions as these the Ingersoll-Sergeant Drill Company, of New York, has placed on the market its latest type of machine channeler which has been given the distinctive name of "Broncho," perhaps because of its tough, rough and ready character, its tireless strength and its faculty of standing up to work under the most severe conditions of service. The appearance of the machine is clearly shown in the accompanying illustration, which also brings out distinctly some of the more important details. Those familiar with the old-fashioned quarry bar or bar channeler will doubtless see some resemblance between them and this new machine.



INGERSOLL-SERGEANT "BRONCHO" CHANNELER.

But while the "Broncho" is an outgrowth and development of the old bar channeler, its distinctive features of design, operation and construction mark it as an entirely new type of machinery.

The frame of the "Broncho" is a structure combining great simplicity and strength. The bars are of heavy pipe rigidly secured in sturdy end castings. Between the bars the heavy steel traveling screw is firmly mounted. The end castings of the frame are swivelled in heavy end pieces, to which are joined the connections. Cone clamp effect is secured at all these joints, and the result is a structure of great flexibility and almost universal adjustment, yet of the utmost rigidity when pressure is applied.

The channeling machine proper is in no sense a rock drill, but a heavy cutting engine designed to secure great strength and effectiveness. The cylinder has a diameter of 3½ inches and a full stroke of 6 inches, variable down to a minimum of two inches. For starting cuts, working through soft spots, and cutting across splits or seams, where the full blow is not desirable, a most valuable feature is provided in a cushioning device whereby the blow may be varied from the merest tap to a blow of full power. A feature exclusively used by the Ingersoll-Sergeant Drill Company is an extended tail rod, being a back piston passing through the rear head.

This is the only channeler which will both cut an open channel and drill a round hole, at any angle from horizontal to vertical. The engine has two rotations; one around the axis of the frame, the other around an axis at right angles to this one. While the best results with this machine are secured by the use of high-pressure steam or air, the valve motion is such as to secure, with low pressure and wet steam, results superior to those to be obtained with machines of older types under even the best conditions.

The net weight of the "Broncho" channeler is about 3,000 pounds. It is designed to make a cut of 10 feet 6 inches long to a depth of 12 feet. The capacity varies, of course, with the pressure used and the material cut. Its best work is done with a pressure of about 100 pounds at the throttle and cuts 7 to 10 feet deep. It uses about 175 cubic feet of free air per minute, or requires a boiler of 20 to 25 horse power.

The "Broncho" channeler is characterized by the three qualities so distinctive of Ingersoll-Sergeant machinery: economy, reliability and simplicity. In the field it is sure to meet with the cordial approval of all practical quarry men, and further information will be supplied by the Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

NEWS SUPPLEMENT

The Engineering Magazine—January, 1905

Coming Society Meetings.

AMERICAN ELECTROCHEMICAL SOCIETY. Sec.: S. S. Stadler, 39 S. 10th St., Philadelphia. Next meeting, April 25-27, at Boston.

AMERICAN FOREST CONGRESS. Sec.: Wm. L. Hall, Atlantic Building, Washington, D. C. Meeting under the auspices of the American Forestry Association, Jan. 2 to 6, at Washington.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Sec.: Ralph W. Pope, 95 Liberty St., New York. Meetings on fourth Friday of each month at Carnegie Hall, 154 W. 57th St., New York. Subject for Jan. 27: Central Stations.

AMERICAN INSTITUTE, POLYTECHNIC SECTION. Sec.: George Whitefield, Jr., 19 W. 44th St., New York. Meetings on first and third Tuesdays of each month, from October to May, inclusive.

AMERICAN RAILWAY ASSOCIATION. Sec.: W. F. Allen, 24 Park Place, New York. Next meeting, April 5, at New York.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION. Sec.: J. W. Taylor, 658 Rookery, Chicago. Meeting, June 14 to 16, at Oriental Hotel, Manhattan Beach, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS. Sec.: C. W. Hunt, 220 W. 57th St., New York. Regular meetings, first and third Wednesdays of each month, except July and August.

BOSTON SOCIETY OF CIVIL ENGINEERS. Sec.: S. E. Tinkham, 715 Tremont Temple. Regular meetings on third Wednesday of each month, except July and August.

BROOKLYN ENGINEERS' CLUB. Sec.: J. Strachan, 191 Montague St. Regular meetings on second Thursday of each month.

CANADIAN RAILWAY CLUB. Sec.: W. H. Rosevear, Jr., Montreal. Regular meetings on first Tuesday of each month, except June, July and August.

CANADIAN SOCIETY OF CIVIL ENGINEERS. Sec.: Prof. C. H. McLeod, 877 Dorchester St., Montreal. The General Section and the Electrical, Mechanical and Mining Sections meet on different Thursdays, from October to May.

CENTRAL RAILWAY CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on second Friday of January, March, May, September and November, Hotel Iroquois, Buffalo.

CHICAGO ELECTRICAL ASSOCIATION. Sec.: W. B. Hale, Monadnock Building. Regular meetings on first and third Fridays of each month, from October to May.

CIVIL ENGINEERS' CLUB OF CLEVELAND. Sec.: Joseph C. Beardsley, 689 The Arcade. Regular meetings on second and fourth Tuesdays of each month.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL. Sec.: G. S. Edmonstone. Regular meetings on second Monday of each month.

ENGINEERING ASSOCIATION OF THE SOUTH. Sec.: Robt. L. Lund, 2102 Hayes St., Nashville, Tenn. Regular meetings on second Thursday of each month at the Berry Block.

ENGINEERS' CLUB OF CHICAGO. Sec.: B. W. Thurtell, 1223 New York Life Building. Regular meetings on first and third Tuesdays of each month.

ENGINEERS' CLUB OF CINCINNATI. Sec.: C. H. Meeds, P. O. Box 333. Regular meeting on third Thursday of each month, except July and August.

ENGINEERS' CLUB OF COLUMBUS (OHIO). Sec. H. M. Gates, 5½ West Broad St. Regular meetings on third Saturday of April, May, June and September, and on first and third Saturdays from October to March, inclusive.

ENGINEERS' CLUB OF MINNEAPOLIS. Sec.: Jas. B. Gilman, American Bridge Co. Regular meetings on third Monday of each month, except July and August.

ENGINEERS' CLUB OF PHILADELPHIA. Sec.: Walter Loring Webb, 1122 Girard St. Regular meetings on first and third Saturdays of each month, except July and August.

ENGINEERS' CLUB OF ST. LOUIS. Sec.: R. H. Fernald, 3817 Olive St. Regular meetings on first and third Wednesdays of each month.

ENGINEERS' SOCIETY OF WESTERN NEW YORK. Sec.: H. B. Alverson, 533 Ellicott Square, Buffalo. Regular meetings on first Tuesday of each month.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA. Sec.: Chas. W. Ridinger, 410 Penn Ave., Pittsburg. Regular meetings on third Tuesday of each month.

FRANKLIN INSTITUTE. Sec.: Dr. Wm. H. Wahl, 15 South 7th St., Philadelphia. General meetings on third Wednesday of each month, except July and August. General section meetings every Thursday.

HONOLULU ENGINEERING ASSOCIATION. Sec.: G. F. Bush, Honolulu, Hawaii.

INTERNATIONAL RAILWAY CONGRESS. General Sec.: Louis Weissenbruch, Belgian State Railways, Brussels, Belgium. Sec. of American Section: W. F. Allen, 24 Park Place, New York. Seventh session, May 3-15, 1905, at Washington.

IOWA RAILWAY CLUB. Sec.: A. T. Woodruff, Des Moines, Iowa. Regular meetings on second Monday of each month.

LOUISIANA ENGINEERING SOCIETY. Sec.: G. W. Lawes, 806 Gravier St., New Orleans. Regular meetings on second Monday of each month.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Sec.: Charles S. Clark, 70 Kilby St., Boston. Meetings second Wednesday of each month, except July and August.

MASTER CAR BUILDERS' ASSOCIATION. Sec.: J. W. Taylor, 658 Rookery, Chicago. Meeting June 19-21, Oriental Hotel, Manhattan Beach, New York.

MICHIGAN ENGINEERING SOCIETY. Sec.: F. Hodgman, Climax. Annual meeting January 11-13, at Lansing.

MONTANA SOCIETY OF ENGINEERS. Sec.: Clinton H. Moore, Butte, Mont. Regular meetings on second Saturday in each month.

MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK. Sec.: Wisner Martin, Cambridge Court, 142 W. 49th St. Meetings on fourth Wednesday of every month, except June, July and August, at Chemists' Club, 108 W. 55th St. Annual meeting on fourth Wednesday in January.

NEW ENGLAND RAILROAD CLUB. Sec.: Edw. L. Janes, Back Bay P. O., Boston. Regular meetings second Tuesday in each month, except June, July, August and September, at Pierce Hall, Copley Square.

NEW ENGLAND STREET RAILWAY CLUB. Sec.: J. H. Neal, 101 Milk St., Boston. Meetings on last Thursday of each month.

NEW ENGLAND WATER WORKS ASSOCIATION. Sec. Willard Kent, 715 Tremont Temple, Boston. Annual meeting January 11, at Boston.

NEW YORK ELECTRICAL SOCIETY. Sec.: Geo. H. Guy, 114 Liberty St., New York. Meetings monthly, on different Wednesdays, at the American Institute, 19 W. 44th St.

NEW YORK RAILROAD CLUB. Sec.: Harry D. Vought, 62 Liberty St., New York. Regular meetings on third Friday of each month, except June, July and August, at Carnegie Hall, 154 W. 57th St., New York.

NORTH-WEST RAILWAY CLUB. Sec.: T. W. Flannagan, Minneapolis, Minn. Regular meetings on first Tuesday after second Monday of each month, except June, July and August, alternating between Minneapolis and St. Paul.

PACIFIC COAST ELECTRICAL TRANSMISSION ASSOCIATION. Sec.: Geo. P. Low, 237 Cherry St., San Francisco. Annual convention, third Tuesday in June. Intermediate meetings subject to call.

PACIFIC COAST RAILWAY CLUB. Sec.: C. C. Borton, West Oakland, Cal. Regular meetings on third Saturday of each month at San Francisco and other cities.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS. Sec.: Prof. M. Roberts, Seattle, Wash. Meetings monthly in Chamber of Commerce rooms, Seattle.

RAILWAY CLUB OF PITTSBURG. Sec.: J. D. Conway, P. & L. E. R. R., Pittsburg, Pa. Regular meetings on fourth Friday of each month, except June, July and August, at Hotel Henry.

RAILWAY SIGNAL ASSOCIATION. Sec.: H. S. Balliet, South Bethlehem, Pa. Regular meetings on second Tuesday of January, March, May, September and November.

RAILWAY WATER SUPPLY ASSOCIATION. Sec.: F. W. Hayden, Glencoe, Minn. Meetings on first Sunday of each quarter, at Alexander Hall, South Minneapolis, Minn.

RICHMOND RAILWAY CLUB. Sec.: F. O. Robinson, 8th and Main Sts., Richmond, Va. Regular meetings on second Thursday of each month, except June, July and August.

ROCKY MOUNTAIN RAILWAY CLUB. Sec.: M. M. Currier, Colorado City. Regular meetings on second Tuesday of each month, except June, July and August, at Union Depot, Denver.

ST. LOUIS RAILWAY CLUB. Sec.: E. A. Chenery, Union Station, St. Louis. Regular meetings on second Friday of each month, except July and August.

SOCIETY OF CHEMICAL INDUSTRY. NEW YORK SECTION. Sec.: H. Schweitzer, 40 Stone St. Meetings on third Friday after the first Monday of each month, except June, July, August and September, at Chemists' Club, 108 W. 55th St.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB. Sec.: W. A. Love, Atlanta, Ga. Regular meetings on third Thursday of January, April, August and November, at Atlanta.

TECHNICAL SOCIETY OF THE PACIFIC COAST. Sec.: Otto von Geldern, 31 Post St., San Francisco. Regular meetings on first Friday of each month.

TECHNOLOGY CLUB OF SYRACUSE. Sec.: A. Frederic Witmer, 707 Dillaye Building. Meetings monthly, except in June, July, August and September.

TEXAS RAILWAY CLUB. Sec.: T. H. Osborne, Pine Bluff, Ark. Regular meetings on third Monday of April and September.

TOLEDO SOCIETY OF ENGINEERS. Sec.: L. M. Gram, 519 Gardner Building, Toledo, O. Meetings on third Friday of each month in National Union Building.

WESTERN RAILWAY CLUB. Sec.: J. W. Taylor, 658 Rookery, Chicago. Meetings on third Tuesday of each month, except June, July and August, Auditorium Hotel, Chicago.

WESTERN SOCIETY OF ENGINEERS. Sec.: J. H. Warder, Monadnock Block, Chicago. Regular meetings on first Wednesday and extra meetings on third Wednesday of each month, except July and August.

WOOD PRESERVERS' ASSOCIATION. Sec.: C. W. Berry, Laramie, Wyo. First annual meeting, January 16-19, at New Orleans.

Personal.

—Mr. J. Newton Gunn recently delivered a lecture on "The Working Organization of a Business Enterprise," at the opening session of the class in business economy at the West Side Young Men's Christian Association, New York.

—Mr. W. Newcomb Carlton has been chosen fourth vice-president of the Westinghouse Electric and Manufacturing Co., succeeding Mr. L. A. Osborne, who has been advanced to third vice-president. Mr. P. F. Kobbe has been obliged to resign the latter position on account of ill health, but will continue to be a director of the company.

—Mr. George D. James, C. E., E. M., of 615 Mining Exchange Building, Denver, has been appointed civil engineer to the Colorado State Board of Health, and will investigate all sanitary matters pertaining to that State.

—Dr. Louis Duncan has been retained by the Allis-Chalmers Company as an expert in electrical patent work in connection with its Electrical Department, The Bullock Electric Manufacturing Company, of Cincinnati. This connection has only recently been made possible by the retirement of Dr. Duncan from the Chair of Electrical Engineering at the Massachusetts Institute of Technology, to which he was appointed in 1902. Finding that it would be impossible to do justice to the Institute unless he gave up his constantly growing business as a consulting engineer and expert, Dr. Duncan decided to resign his chair. Dr. Duncan will continue to make his headquarters in New York, at 56 Pine Street, where he will be closely in touch with the legal and executive offices of the Allis-Chalmers Company.

Industrial Notes.

—The Vulcan Iron Works Co., of Toledo, O., have issued a vest-pocket diary which is arranged in very convenient form, and which contains, besides the blank pages for memoranda, accounts and addresses, a great deal of useful information in compact shape, as well as maps of the United States and outlying possessions.

—The Harrison Safety Boiler Works, of Philadelphia, have been awarded a gold medal for their Cochrane feedwater heaters and purifiers shown in the exhibit of the Philippine Government Board at the Louisiana Purchase Exposition, at St. Louis. Another gold medal has been awarded for the general exhibit of the Cochrane heaters, the Sorge-Cochrane System (for the thorough heating and purification of water for boiler feed and other purposes), and the Cochrane steam and oil separators.

—The Ball Engine Co., of Erie, Pa., have recently received an order from the New York and Pennsylvania Co., of Johnsonburg, Pa., for two 1,000-horse-power vertical, cross-compound, Corliss engines, for direct connection to electric generators.

—The American Water Softener Co., of Philadelphia, have been compelled, by their constantly increasing business, to move into more commodious offices, and have combined the laboratory with the general sales department. They now occupy a large suite of offices in the Mutual Life Building, 1011 Chestnut St., Philadelphia.

—The A. D. Granger Co. has moved its Philadelphia office to the Commonwealth Trust Building, Chestnut and Twelfth Sts., Philadelphia, where much larger and more commodious apartments have been fitted up. Mr. T. M. Simpson remains as manager of this office, his territory covering the eastern portion of Pennsylvania, from Harrisburg to Philadelphia, and the southern half of New Jersey.

—The Stow Flexible Shaft Company, of Philadelphia, while not desirous of making any forecast for future business conditions, express themselves as being perfectly satisfied with those now existing. Among the many orders received during the past month were the following: A Halsey portable drill for a firm in Vancouver, B. C.; an 18-foot flexible shaft, and a large crank-pin turning machine, for their St. Louis agent; and three complete electric hammer outfits, to be shipped to Italy for use in the Government navy yards.

—J. A. Fay & Egan Co., of Cincinnati, the manufacturers of woodworking machinery, have been awarded a medal at the St. Louis World's Fair, on the fine operation of one of their tools. The firm had no regular exhibit, but some of their tools were operated by other concerns for exhibiting various products in connection with which woodworking tools were required.

—*The American Architect,* which has been published in Boston since 1875, has been purchased by a New York corporation, at the head of which is Mr. F. P. Burt, lately manager of the *Engineering News,* but Mr. William Rotch Ware continues to be associated with the editorial management. The main office of *The American Architect* is now in the Times Building, Broadway and 42d St., New York.

—The Illinois Steel Company, through their Cement Department, are distributing two attractive booklets, neatly bound in flexible cloth. One is entitled, "Facing and Finishing Exposed Concrete Surfaces," and is reprinted from "Reinforced Concrete," by A. W. Buel and C. S. Hill. The other contains the report of the Committee of the American Society for Testing Materials on "Standard Specifications for Cement."

—The Lawrence Pump and Engine Co., of Lawrence, Mass., has recently been incorporated to manufacture a complete line of improved centrifugal pumps. Mr. H. L. Mellor, who has been engaged for several years in designing and building this class of machinery, is general manager of the company.

—A. Leschen & Sons Rope Co., of St. Louis, received three grand prizes, the highest awards, for their exhibits at the St. Louis Exposition, one for wire rope, one for wire-rope tramways, and one for conveying and transmission haulage outfits.

—The Reeves Engine Company have opened an office at 1612 Monadnock Building, Chicago, which will be in charge of Mr. Joseph B. Hall.

—J. A. Fay & Egan Co., of Cincinnati, the manufacturers of woodworking machinery, announce the opening of their new offices in Chicago, in the Railway Exchange Building, suite No. 751. The offices will be in charge of Mr. Everett S. Kiger, and visitors to Chicago who are interested in woodworking machinery are cordially invited to make these offices their headquarters. J. A. Fay & Egan Co. will hereafter do all business in this territory direct.

—The Abner Doble Company, of San Francisco, have been awarded a grand prize for their exhibit of a tangential water wheel at the St. Louis Exposition. This wheel developed 170 horse-power at a speed of 700 revolutions per minute with a water pressure of 500 pounds per square inch, equivalent to a hydraulic head of nearly 700 feet. It was direct connected to a 100-kilowatt Crocker-Wheeler railway generator, which was one of the units of the Intramural power plant.

—The Triangle Protractor Company, of Worcester, Mass., has recently brought out a 45° celluloid triangle, with a sliding bar protractor which can be read to ten minutes. It is reversible and invertible.

—The A. S. Cameron Steam Pump Works, of East 23d Street, New York, had a display in machinery Hall, at the St. Louis Exposition, which was awarded the gold medal and commended by all good judges of pumps who inspected the exhibit. Besides a number of regular patterns on exhibition, there was a Cameron fuel-oil pump and heater, for use in connection with an oil-burning system, the distinctive features being the by-pass valves and piping, to avoid, when desired, pumping oil through the heater. This is important, as exhaust steam may be utilized to heat the oil to any degree necessary by using the by-pass in connection with it. There were also an oil-line pump for handling crude oil or a fine petroleum, a vertical boiler feed pump, a vertical deep-well engine, several contractors' differential pumps and the well-known Cameron vertical plunger and piston sinking pumps for mine service. Another type shown was a large pot-valve pump, designed for mine station pumping and heavy service. This is of a very modern type, and is especially noted for its employment in mines which are subject to floods from surface drainages or workings, or from cutting into subterranean bodies of water, which necessarily must be pumped out in short order, and also where the water is strongly impregnated with sulphur and the use of the ordinary iron pump prohibited. A number of their pumps were also placed in actual service at the Exposition, so forming a working exhibit and practically demonstrating their many good points. The works and general offices of The A. S. Cameron Steam Pump Works are in New York City, but they are directly represented in the principal cities in this country and foreign lands, having over sixty branches or agencies at home and abroad. They have recently published a miniature catalogue of novel and attractive design and their new and complete catalogue is ready for distribution.

—The G. Drouve Company, of Bridgeport, Conn., manufacturers of cornices, skylights, finials, etc., have issued their annual calendar, which is particularly suitable for offices, the figures being large and clear and not interfered with by any advertising matter. The top half of the calendar is devoted to a representation of the wares that they manufacture. A copy of this calendar will be sent upon request.

—The F. W. Foster Mfg. Co., the makers of shaking grates, float valves and other steam and water specialties, have been compelled, owing to their increased business, to move to more commodious quarters, and are now located in their new office and salesrooms, at 99 Haverhill Street, Boston.

—The Department of Mechanics of the University of Arizona has started an indexed catalogue file, and requests catalogues of steam and gas engines, electrodynamic, hydraulic, mining and milling machinery, fittings and supplies. They will be used for purposes of instruction, as will also a collection that is being formed of mechanical devices, machine parts, fittings, and samples of supplies and materials of machine construction. Any contribution to the collection will be very welcome. Address Prof. E. M. Blake, University of Arizona, Tucson, Ariz.

—The American Society of Refrigerating Engineers was organized on December 5, at 12 W. 31st Street, with the following officers: President, John E. Starr; vice-presidents, P. De C. Ball and H. B. Roelker; treasurer, W. C. Reid; secretary, Wm. H. Ross, Produce Exchange Annex, New York; directors, W. E. Parsons, Henry Torrance, Jr., E. L. Phillips, D. S. Jacobus, L. H. Jenks, Louis Block, Edgar Penney, W. T. Robinson and Thomas Shipley.

—The Erie Railroad, owing to its geographical situation and the great natural resources of the region it traverses, offers peculiar advantages to manufacturers for the location of their plants. Running, as it does, from New York to Chicago through the States of New York, New Jersey, Pennsylvania, Ohio, Indiana and Illinois, and traversing great coal, oil and natural gas fields on its way, it enables manufacturers to easily obtain supplies of raw material, and at the same time gives them direct access to the principal markets of the country. A great many industries have recently been located along this railroad, and manufacturers who contemplate the establishment of new plants will find it to their advantage to communicate with Luis Jackson, Industrial Commissioner, Erie Railroad Company, 21 Cortlandt Street, New York.

—The Crocker-Wheeler Company, of Ampere, N. J., through its Pacific Coast managers, the Abner Doble Company, of San Francisco, has secured a contract from the California Gas and Electric Corporation, of San Francisco, for three 4,000-kilowatt, 3-phase, 13,200-volt, 25-cycle, revolving-field alternators, to be driven at a speed of 83 revolutions per minute by 6,000 horse-power gas engines built by the Snow Engine Company. These generators are the largest in capacity in the world driven by gas engines, and will furnish power for operating all the street railways in San Francisco and vicinity. This important sale by a company which has been building alternating-current machinery only a few months is a cause for congratulation. It is due in part to the fact, as announced several months ago, that the Crocker-Wheeler Company is the American licensee of Brown, Boveri & Cie, the celebrated Swiss electrical engineers. But the reputation for excellence which the Crocker-Wheeler Company has built up during the past sixteen years of manufacture of direct-current apparatus has had much to do with the result.

—A memorable incident of the morning following the close of the St. Louis Exposition was the formal shut-down and inspection of the 600 horse-power Westinghouse steam-turbine generating unit in the Palace of Machinery after a continuous run of over 3,962 hours, a performance which has had no parallel in steam-turbine history. This machine was started on its long run at 9:20 o'clock on the morning of Monday, June 20, shortly after its installation at the Fair, and was stopped at 11:32 o'clock on the morning of Friday, December 2. During the five and a half months that the unit was in operation it supplied current for light and power throughout the Westinghouse exhibits in the Palaces of Machinery, Electricity, and Transportation. Charles F. Foster, chief operating engineer of the Exposition; H. M. Holman, supervising engineer at the Government Exposition gas-engines tests, formerly president of the St. Louis Board of Public Works, and a number of Westinghouse representatives, including Wallace Franklin, of Detroit; C. C. Chappelle, of Chicago, and W. K. Dunlap, managing director of the Westinghouse exhibits, were present when the engine was stopped. It was found to be in perfect condition, and there were no signs of wear, the bearings still retaining the tool marks as they had come from the shops. There have been at least two instances on record in America in which piston engines have been run continuously for about the same length of time as that of the record run of the Westinghouse turbine. The remarkable feature of the turbine run, of course, was the maintenance under load of a speed of 3,600 revolutions a minute for such a long period. From 8:30 o'clock in the morning to 10:30 o'clock in the evening, the load carried throughout the Exposition varied from 25 per cent. underload to 25 per cent. overload. The total number of revolutions almost touched the billion mark—855,792,000.

—One of the greatest, and, in many respects, the most spectacular water-supply system ever undertaken is that for the Coolgardie district, in Western Australia. Nearly six million gallons per day are taken from the Helena River, near the coast, and forced through a 300-mile steel pipe line across waterless deserts by eight pumping stations, which are equipped with triple-expansion, high-duty Worthington pumping engines. The contractors for this machinery were Messrs. James Simpson & Co., Limited, of London.

—The Northern Electrical Manufacturing Co., of Madison, Wis., recently received an order for three 150-kilowatt, slow-speed generators from the Tennessee Coal, Iron & Railroad Co., of Birmingham, Ala. This order was received through J. B. McClary & Co., the Birmingham representatives of the Northern Electrical Manufacturing Co. The Lee Paper Company, of Vicksburg, Mich., has lately ordered a 200-kilowatt Northern generator for the equipment of its new mill. This is the most recent in a long series of sales of Northern apparatus for paper-mill work, the most prominent installation being the plant of the Consolidated Water Power & Paper Company, of Grand Rapids, Wis., in which are operated a quantity of Northern motors of all sizes, as well as two 300-kilowatt direct-current generators. The Consolidated Water Power & Paper Co.'s plant contains, among other motors, two large single-voltage variable-speed motors, operating from the mill power circuit and giving speed variations from 300 to 500 revolutions per minute, corresponding with machine speeds of 50 to 500 feet per minute.

—The Rhode Island College of Agriculture and Mechanic Arts has established a course in highway engineering, full particulars of which may be had by addressing President Kenyon L. Butterfield, Kingston, R. I.

—The Pennsylvania Railroad System has received a special commemorative grand prize from the Louisiana Purchase Exposition "for its original series of scientific investigations of locomotive performance conducted there, the methods and results of which are a permanent contribution to the advancement of engineering knowledge." The Pennsylvania Railroad has also received seven other grand prizes and three gold medals for its large and fine exhibits, and gold medals were awarded to each of the collaborators in connection with the preparation of the exhibits and the testing plant.

—The Wager Computing Scale Company, of Philadelphia, have brought out a convenient and ingenious timber scale for computing the strength of wooden beams, which will be a great time saver for anyone interested in the design of wooden structures.

—The Columbia University fire-testing station is equipped with buildings suitable for testing floors, partitions, columns, doors, windows, and all varieties of building construction in full-sized units. A complete laboratory equipment is available for making fire and other physical tests upon small samples. A report of a fire, load and water test, made at this testing station, upon a Kahn system, 15-foot-span, reinforced-concrete floor, constructed by the Trussed Concrete-Steel Company, of New York, has recently been issued. This test was conducted by Ira H. Woolson, E. M., adjunct professor of mechanical engineering at Columbia University, in co-operation with the New York City Building Bureaus.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Prospector's Drills.

"The Diamond Drill and Its Work" is the title of an eighty-page illustrated pamphlet, which should hold a place in the reference library of every engineer and manager who is either directly or indirectly concerned with testing the strata of the earth. In its pages are embodied the results of over thirty years of expert and practical experience in all parts of the world; it is arranged logically throughout, and is carefully indexed; it deals only with practical results, based upon actual performances of the machine; it illustrates all the standard types, from the hand power drill to the highest motive power machines; and as a whole it constitutes a serviceable, suggestive and valuable handbook of the subject. American Diamond Rock Drill Co., Box 1442, New York, U. S. A.

Rock Drill Tests.

In response to many inquiries for "exact details" as to the rock drill tests held at the City and Suburban gold mines, Johannesburg, South Africa, The Rand Drill Co., 128 Broadway, New York, have issued an illustrated folder presenting the complete table of each run as published in the Journal of the Mechanical Engineers Association of the Witwatersrand, together with the report by Mr. J. D. Carper, M. E. Free upon request.

Gravity Planes.

An illustrated eight-page pamphlet giving a detailed description of the celebrated "Stine" gravity planes, which in recent years have been so successfully adopted throughout the mining regions of the United States. Striking testimonials from users are presented, and the detailed description of the mechanism will be of interest and value to mining engineers and mine managers who are concerned with the problems of transporting materials by gravity. S. B. Stine & Son, Osceola Mills, Pa., U. S. A.

Cranes.

Illustrated catalogue and general description of jib cranes, swing cranes, pillar cranes, car cranes, locomotive cranes, traveling cranes, and other styles, in capacities ranging from 5 tons to 150 tons. Most of these cranes are driven electrically, but some are worked by hand or by hydraulic power, and many of them are shown in operation at prominent engineering and manufacturing works. 9 by 7¼ in.; pp. 48. William Sellers & Co., Incorporated, Philadelphia.

Booklet No. 19, illustrating and describing electric traveling cranes in many sizes and for various purposes, jib cranes of different types, locomotive cranes, air hoists, electric hoists, and other kinds of cranes and hoisting machinery. 3½ by 5½ in.; pp. 28. Northern Engineering Works, Detroit.

Automobile.

Catalogue, giving a very well illustrated description of the Adams-Farwell motor car and the history of its development. This automobile has a convertible Brougham body, a revolving-cylinder, air-cooled motor and many other novel and attractive features. 6 by 9½ in.; pp. 32. The Adams Company, Dubuque, Iowa.

Arc Lamps.

Bulletins Nos. 7030, 7035 and 7,040 devoted, respectively, to multiple-series and constant-current arc lamps for direct-current circuits; multiple constant-potential alternating-current arc lamps; and multiple constant-potential direct-current arc lamps. 10¾ by 7¾ in. Western Electric Company, Chicago.

Boring Mills.

Catalogue, of artistic design, with descriptions and handsome illustrations of vertical and horizontal boring mills, turret lathes and tool grinder. 9½ by 7¾ in.; pp. 28. Gisholt Machine Company, Madison, Wis.

Cement Machinery.

Large pamphlet, entitled "The Construction of a Modern Cement Plant," containing half-tone illustrations, an account of Portland and other kinds of cement, descriptions of many large cement manufacturing plants, useful information about cement, and a review of the Dodge American system of power transmission by Manila rope, which is extensively used in cement plants. 12 by 9¼ in.; pp. 75. Dodge Manufacturing Co., Mishawaka, Ind.

Controller.

Bulletin No. 1, giving an illustrated description of the "Rheocrat," a controller for electric motors, particularly those driving machine tools, which will give uniform gradations of speed over a wide range, consumes very little power and can be readily adapted to plants already in operation. 9 by 6 in.; pp. 4. American Electric & Controller Company, 12 Dey St., New York.

Cooper Hewitt Lamps.

Bulletin No. 5, containing illustrated descriptions of the Cooper Hewitt mercury vapor lamp, which consists of a vacuum tube containing a little metallic mercury, which becomes vaporized on the passage of an electric current and emits an intense highly efficient light. Many applications of this lamp are shown, particularly to all kinds of photographic work, for which it is admirably adapted. 9 by 6 in.; pp. 26. Cooper Hewitt Electric Co., 220 West 29th St., New York.

Drawing Pens.

Circular, with illustrations, descriptions and prices of an improved fountain ruling pen and a "universal" dotting pen. 9 by 5¾ in.; pp. 2. Kolesch & Co., 138 Fulton St., New York.

Electric Apparatus.

Bulletins, flyers and other publications, containing illustrated descriptions of transformers for thawing out pipes, attachments for circuit breakers, continuous-current railway switchboards, curve-drawing instruments for alternating-current circuits, modern long-distance electrical transmissions, Edison miniature incandescent lamps, "Noblac" heat-resisting enclosing globes for arc lamps and other electric apparatus and their auxiliaries. General Electric Co., Schenectady, N. Y.

Electric Machinery.

Pamphlet, showing the salerooms, repair department, testing department and other views of the Guarantee Electric Co., with short descriptions of their business in second-hand electric apparatus, which they guarantee for one year. 7 by 10¾ in.; pp. 14. Guarantee Electric Co., Chicago.

Filtration.

Catalogue, containing descriptions and illustrations of water filters of many different types and for all kinds of service, from dwelling houses to the largest waterworks systems, with views of some notable filtration installations, list of municipal filter plants, and testimonials. 6 by 9¼ in.; pp. 48. The New York Continental Jewell Filtration Co., 15 Broad St., New York.

Gas Producers.

Catalogue B, containing descriptions and illustrations of automobile gas producers, suction gas producers, and water-bottom gas producers for making gas for gas engines and furnace and heating work from coal and many other kinds of fuel. 9 by 6 in.; pp. 17. Wile Power Gas Co., Rochester, N. Y.

Magnetic Separators.

Pamphlet containing an account of the treatment of pyritic zinc ores, and an illustrated description of the Cleveland-Knowles electromagnetic separator and its method of operation in separating the iron minerals of ores from the other constituents. 9 by 6 in.; pp. 18. United Iron Works Co., Springfield, Mo.

Mechanical Stokers.

Pamphlet containing handsome illustrations and descriptions of the Roney mechanical stoker and its details, with diagrams showing the uniformity of steam pressure secured by its use, and views of some of the great power stations where it is installed. Boilers with an aggregate capacity of one million horse power have been equipped with this stoker. 6¾ by 9 in.; pp. 62. The Westinghouse Machine Company, East Pittsburg. Pa.

Packing.

Catalogue, with half-tone illustrations and descriptions of the "Kantblo" plastic metallic packing and some of its applications, together with many testimonials from users. This packing can be used to advantage for piston rods, steam hammers, air compressors, locomotive air pumps and throttle stems, stop valves, Corliss valves and valve stems and anywhere that steam or compressed air is used. 5½ by 8½ in.; pp. 46. Plastic Metallic Packing Co., Pittsburg.

Rock Drills.

Catalogue, containing descriptions, half-tone illustrations and line cuts of rock drills of various sizes, for use with compressed air or steam, drill mountings and their details, with useful tables and information. 9 by 6 in.; pp. 32. Also, circulars with illustrated descriptions of these rock drills, and testimonials from users. Wood Drill Works, Paterson, N. J.

Rolling-Mill Machinery.

Large, cloth-bound catalogue, containing descriptions and half-tone illustrations of rolls, roll turning lathes, shears, punches, rail and angle straighteners, hot and cold metal saws, hydraulic accumulators, intensifiers and cranes, grinding mills, squeezers, ingot cars, tube-works machinery, and all kinds of rolling mills and rolling-mill machinery. 8½ by 10 in.; pp. 205. United Engineering and Foundry Company, Pittsburg.

Spiral Pipe.

Catalogue, bound in flexible cloth, containing descriptions, illustrations and price list of Taylor's spiral riveted pipe for water, steam, compressed air and other purposes, and supplies for hydraulic and exhaust steam piping, with views of long-distance pipe lines for water powers and of other installations and also useful data and tables of hydraulics. 8 by 4 in.; pp. 56. American Spiral Pipe Works, Chicago.

Thawing Outfit.

Bulletin containing description and illustrations of an outfit for thawing frozen water pipes by means of an electric current, consisting of a transformer, a heat indicator, a choke coil and connections. 8½ by 6 in.; pp. 4. Pittsburgh Transformer Company, Pittsburgh.

Twist Drills.

Booklet, containing illustrations, descriptions and prices of reamers, drill chucks, sockets, and, particularly, of twist drills of many styles and sizes. 6 by 3½ in.; pp. 20. The Standard Tool Co., Cleveland, O.

Valves.

Catalogue, containing illustrations, descriptions and prices of the Hancock globe, angle, 60° and cross valves and their parts. These valves are made screwed and flanged in sizes up to three inches, are equipped with tee handles, and have various other valuable features. 9 by 6 in.; pp. 23. The Hancock Inspirator Co., 85-87-89 Liberty St., New York.

Watchman's Clocks.

Pamphlet, containing illustrated descriptions of the Howard electric watchman's clock system, the clock and regulator, the record dial, and other apparatus, together with a long list of users. 8 by 4 in.; pp. 32. The E. Howard Clock Company, 401 Washington St., Boston.

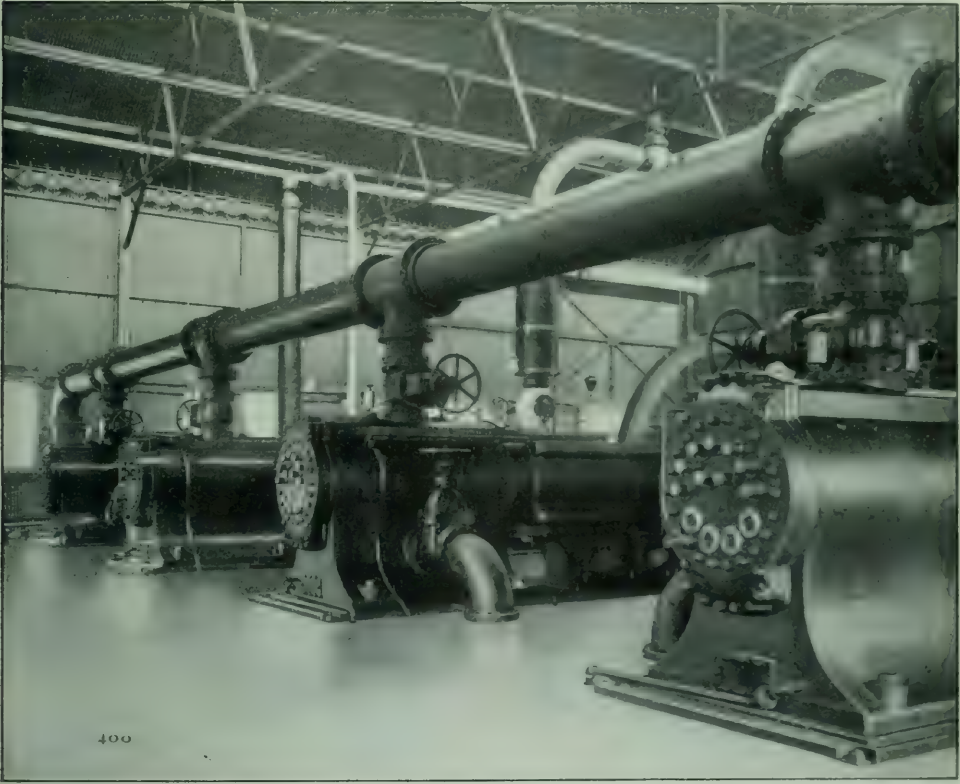
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

A New Gas Compressor Plant.

A NEW and very interesting piece of engineering work is the gas compressor plant recently completed at Hundred, West Virginia, by the United States Steel Corporation, for the purpose of regulating the pressure and supply of natural gas, and thereby avoiding the wholesale wastes which heretofore have been common throughout all the regions where natural gas has been found.



GAS CYLINDERS OF RAND COMPRESSORS AT HUNDRED, WEST VIRGINIA

The great steel works at Homestead, Duquesne, and Bessemer, consume about 65,000,000 cubic feet of natural gas every day. This large quantity of rich fuel is used exclusively for melting and heating steel in the open-hearth furnaces and heaters, and comes directly from their gas wells in Pennsylvania and West Virginia through hundreds of miles of pipe, the main lines varying in diameter from 10 inches to 20 inches These lines are laid just below the frost line, and they follow the natural contour of the ground, over mountains and under streams. The sections of pipe are joined by specially constructed couplings (not screwed) which allow for uneven alignment and the unavoidable expansion and contraction without any leakage.

The supply of natural gas, while still bountiful in certain localities, is gradually diminishing, in spite of the fact that prospect work on new wells is still under way. New fields command greater values today than ever before, and the wholesale waste following the earlier discoveries is by no means as common as it was.

The average depth of natural gas wells in this territory is about 2800 feet, though wells have been drilled to 3500 feet. One well drilled to this depth produced thirty million cubic feet per twenty-four hours; its rock pressure was 800 pounds per square inch, or an open flow pressure through a 6½-inch casing indicated 25 pounds per square inch. Some record wells have produced fifty million cubic feet per day, and rock pressure of 1100 to 1200 pounds are often encountered. The Carnegie Natural Gas Company now has several 1100-pound pressure wells shut in. The roar due to the flow of gas from a well before it is "shut in" can be heard for miles, and millions of cubic feet of gas escape to the atmosphere before it is possible to shut in a well of this kind, as this usually requires about twenty-four hours.

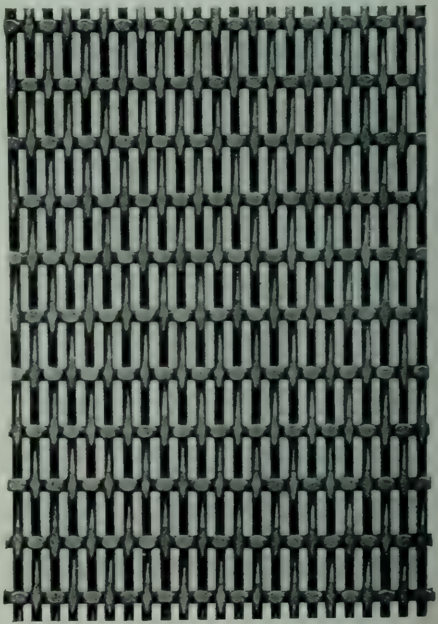
As the wells become exhausted, the natural pressures are lowered, and this means a diminished volume in the pipe lines and diminished returns on the investment. Additional or larger pipe lines would, of course, prolong the supply; but a much less expensive method for accomplishing this purpose is now resorted to, and that is to again raise the pressure by means of gas compressors.

The Carnegie Natural Gas Company, which is part of the United States Steel Corporation, has already installed compressor capacity which has an equivalent artificial yield of one hundred million cubic feet of natural gas per twenty-four hours. This capacity is represented by eight compressors located in three stations, each station being designed for reserve capacity over present requirements, so that all of the eight machines are not always in use.

The most recent and important of these plants, containing many new features and improvements, is located near Hundred, Wetzel County, West Va., a station on the Baltimore & Ohio Railroad. One view of the machinery is shown herewith, and owing to the novelty and importance of the work, The Rand Drill Co. have in preparation a technical description of the entire plant, clearly indicating the details and cost of plant, the method of drilling the wells and constructing the pipe lines, the dimensions and capacity of the gas producers, engines, boilers, the steam and gas piping under specified conditions, the condensing and feed-water equipment, together with indicator cards, and views of the buildings, etc. This detailed and valuable description The Rand Drill Co., 128 Broadway, New York, will be pleased to send free of charge to engineers and others who may be interested in similar plants in other natural gas regions.

Rolled Slot Screens.

A MARKED improvement on the screens hitherto in use for handling ore and similar materials is shown in the accompanying illustration, which represents



TYLER ROLLED-SLOT SCREEN.

the "rolled-slot screen," a new screen cloth especially adapted for stamp batteries, Huntington mills, and so on.

This wire screen has an oblong mesh and is rolled so as to present a smooth surface, in the latter respect being nearly similar to perforated metal. But the rolled-slot screen has a great advantage in its large amount of air space, which is double that in perforated metal. It has also decidedly more air space than the ordinary square-mesh wire cloth, and its construction is such that the particles of ore pass freely through it, without obstructing the apertures, as is sometimes the case with the old styles of screen.

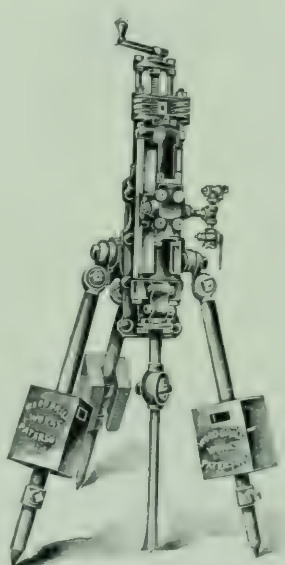
Another point of superiority of the rolled-slot screen is that the crushed particles will pass through it as soon as they are reduced to the size of the aperture, whereas with the perforated screen the particles which are thrown against the blank spaces are returned to the crusher and so ground finer before they pass the screen, this having a tendency to slime the product.

Some interesting figures as to comparative results with different screens are supplied by the Mineral Point Mill, of the Homestake Mining Co., at Lead, South Dakota. In a hundred-stamp mill, running on a low grade of surface ore, in which one half of the batteries were equipped with No. 8 Russia-iron diagonal-slot screens, and the other half with rolled-slot screens of equivalent mesh, a twenty-day run showed an average daily tonnage of 4.57 tons per stamp with the diagonal-slot screen, and 5.64 tons per stamp with the rolled-slot screen, an increase of 24 per cent. with the latter. The nature of the ore in this particular case was favorable to easy crushing which acounts for the large absolute increase in tonnage, but in other experiments, where the tonnage was not as great as in this mill, there has also been a large relative increase by the use of the rolled-slot screen, and it may be said that on an average fifty stamps equipped wth rolled-slot screens will handle the same tonnage daily as sixty stamps with perforated diagonal-slot screens.

Further particulars regarding the rolled-slot screens will be furnished on request, by the manufacturers, The W. S. Tyler Company, of Cleveland, O.

Wood Rock Drills.

THE percussive rock drill has become an indispensable tool for mining, tunneling, quarrying and other kinds of rock excavation, and many of the great engineering works of recent years would not have been commercially practicable without it. When first invented it was, comparatively speaking, a heavy, clumsy and expensive mechanism, but even then it marked a great step in advance, and it has since been developed into the perfected machine of to-day, one of the finest examples of which, the Wood rock drill, is shown in the accompanying illustration.



WOOD ROCK DRILL.

The front head is made of malleable iron, held firmly by four bolts instead of only two, and the head is cored from the inside to receive two case-hardened bolts to hold the packing sleeve in place. This prevents the bolts from wearing the corners away, owing to the jarring of the drill, and falling out, as is the case where the slots are cored from the outside. The malleable iron washer, which fits into the sleeve in combination with the four grooves in the spring nuts, effectually prevents the nuts from unscrewing and falling off.

The packing sleeve is made of hard bronze and can be cheaply replaced when worn out, thus doing away with the expense of buying a new front head.

The air head is designed with a tapering recess for the three packing rings, which form the frustrum of a cone, and leakage is prevented until the packing is entirely worn out.

The rotating device is made of steel throughout; the spiral bar is made of one solid forging, and teeth are strong enough to resist the full power of the drill. The pawl holder is made of one solid forging, not a welded collar. The pawls are drop forged from tool steel. Four steel pins project from the pawl holder into the top head, which holds it firmly.

The valve is made of tool steel, moves automatically, and has no mechanical connection with the piston, to which it gives a variable stroke. As the end spools of the valve never cross a port, this type of valve never freezes when operated anywhere by compressed air. It is very light, does not wear fast, and never breaks. Only this one type of valve is used in the Wood drills, as it has proved to be the best kind for a rock drill.

The shell is of malleable iron, as are the caps, and has projecting lugs above its surface to prevent the caps from being forced back. It is bored at the back to receive solid forged steel standards, and a recess is cored to receive the nut on the end of the standards.

The coil springs, resting on the wrought-iron cross piece, receive the shock when the piston strikes the front head. These springs do not break, or wear out, and will retain their elasticity indefinitely.

The top head is made of malleable iron, and cored at the back to receive the steel feed nut. This is preferable to attaching the feed nut to the cylinder, for there is not power enough in the drill to break the malleable top head, while if held by the cylinder, which is cast-iron, it is more easily broken.

The piston is one solid forging, made of the very best piston steel. The piston bushing is made of steel and hardened on one side only. A slot is milled on the side where the chuck key fits. By using a cape chisel it can be sheared down the slot and easily forced out. The piston rings are made of steel forgings.

The cylinder is made of hard iron for long wear, and has an exhaust on either side. By changing the plug it can be made to exhaust right or left. Sometimes this is very desirable, especially in mines or deep cuts. The cylinder also has a bearing for the side rod to rest on, placed at the side of the cylinder under the exhaust pipe, which prevents the side rods from being bent if the drill is thrown down carelessly.

The tripod is made of steel and malleable iron. The legs are of extra heavy pipe, the top part of which is turned tapering and fits in a taper bearing. The lower portion of the bearing is slotted, and when the bolts are screwed up tight it holds the pipe firmly, and keeps them tight. It is made by templates or gauges, and one part is the exact duplicate of another. It is adjustable in all ways.

Many sizes of these machines, to be run with compressed air or steam, are manufactured by the Wood Drill Works, of Paterson, N. J., which make a specialty of rock drills and drill mountings, and devote all their energies to this end. They will be pleased to supply further information on request.

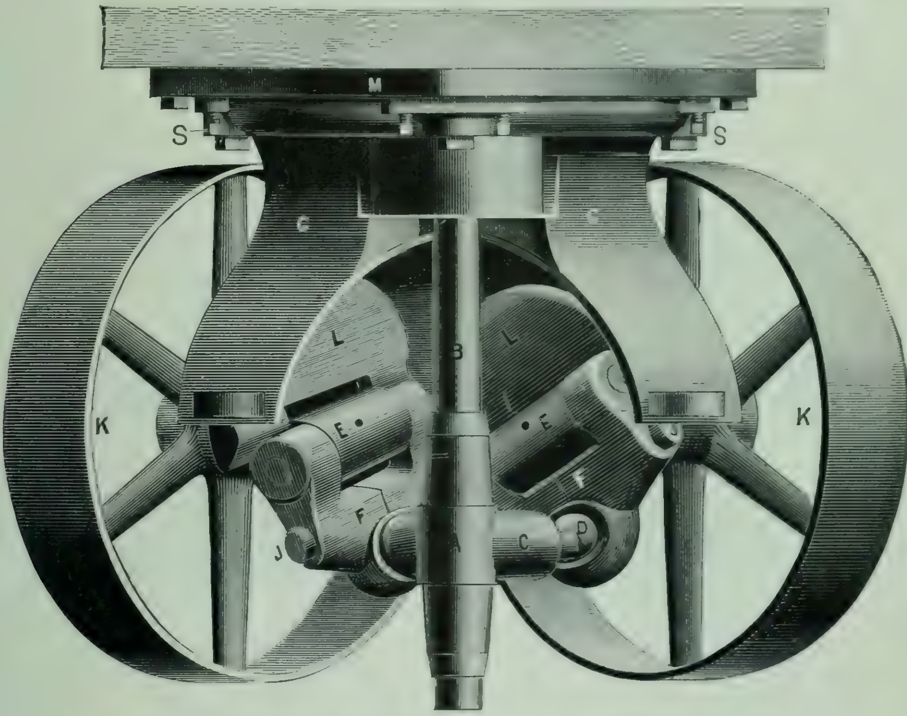
Almond Right-Angle Coupling.

IN the transmission of motion between lines of shafting at right angles to each other, by means of the usual devices, there is generally a lot of noise, a waste of lubricant and a great loss of energy. These losses and annoyances are eliminated by the use of the Almond patent coupling, which transmits power at right angles by a positive motion, which is noiseless in its action, consumes very little energy and is self-lubricating.

Its method of operation can be learned from the accompanying illustration, in which the crank arm F is connected with the slide A by the ball D and arm C, the opposite crank arm being connected with the slide A in a precisely similar manner. By revolving one of the crank arms, by means of the pulley K, or from the shafting direct, the slide A is carried up the post B and at the same time is given a rotary motion partly around the post; this motion is communicated to the opposite crank arm, and thence to the pulley and the shafting. Either crank arm can drive or be driven.

Perfect lubrication is effected by introducing oil into the lower half of the frame G (not shown in the illustration), which forms a closed receptacle, and when in motion the arms F, F, in connection with the slide A, will rapidly distribute the oil over the interior of the frame, by which means it reaches the parts to be oiled.

When it is intended to take motion from a central portion of the line shaft, the coupling is suspended from the ceiling at a suitable distance, and connection made with the main line by belt; the shaft to be driven may then be belted in the same way, or it may be connected direct by some suitable means. When pulleys are used, they are fitted to a bearing which is solid with the frame, so that no belt pressure or strain other than torsional may come upon the shaft A.



ALMOND COUPLING, SHOWING LOWER HALF OF FRAME REMOVED.

A template or suspension plate M is furnished with each coupling, for the purpose of easily locating its position. This plate has lines marked on it, and a center point at their intersection. These lines make the same angle with each other as the shafts to which the coupling is to be attached, and should, when the plate is in position on the ceiling, stand plumb with the centers of the driving and the driven shafts, the center point being as nearly as possible right over the point of intersection of the shaft axes. Bolts are provided with this plate for securing the frame G. The set screws S, S are for vertical adjustment, there being eight of them for that purpose.

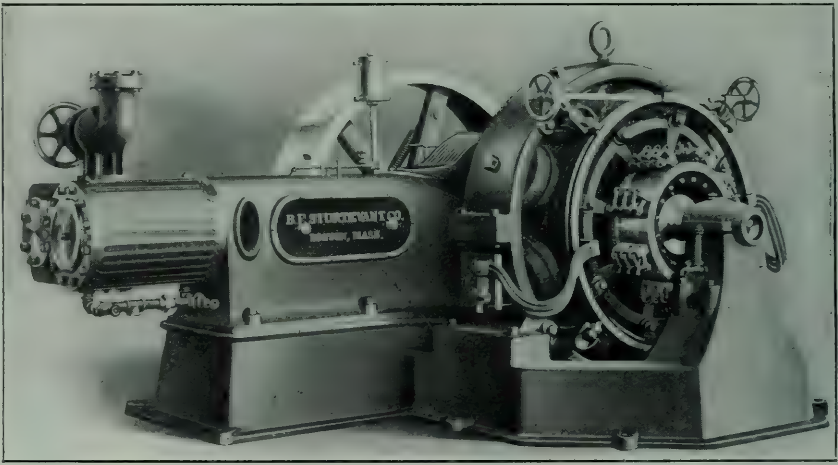
The holes through which the bolts go for securing the frame to plate M are of a size large enough to allow a lateral movement of the frame to an amount of three-quarters of an inch in every direction. From this it will be seen that the adjustment is quickly accomplished, for if the frame G be loosely hung to the plate M at about the right height, and the connections made, it will settle itself to its position laterally, and may then be carefully adjusted vertically by the set screws and suspension bolts, and firmly secured in position.

The Almond coupling is manufactured of the best material and by the most modern methods, the parts being worked to micrometer gauges. It has stood the test of time, and has given the greatest satisfaction in the prominent manufacturing establishments where it is in use, and has received the John Scott Medal on the recommendation of the Franklin Institute.

Further information concerning this coupling, as well as of their other specialties, may be obtained from the T. R. Almond Manufacturing Co., 83-85 Washington St., Brooklyn, N. Y.

A Sturtevant Generating Set.

IN response to the growing demand for a high-class generating set at a reasonable price, the B. F. Sturtevant Company are manufacturing a type, illustrated herewith, which supplies this want. Years of experience in the manufacture of both units have enabled them to perfect such a set.



STURTEVANT GENERATING SET.

The general design of the engine embodies all the latest improvements of the horizontal type. The reciprocating parts are substantially constructed and counterbalanced with lead load discs. A feature of construction is that of forging the crank-shaft solid in one piece and shrinking the discs onto it. A special arrangement of the Rites governor gives a regulation within 1 to 1½ per cent. from full load to no load, and by a modification of the Marshall valve gear an adjustment of the cut-off from zero to 70 per cent. is attained. The main bearings, crankpin, valve stem and slides of this engine are well babbitted with the Sturtevant white metal. A recent and important improvement is the watershed partition which prevents the water from the piston-rod stuffing box from reaching the interior of the engine frame, and the oil on the reciprocating parts from being thrown out into the engine room. The main body of the engine is enclosed on both sides by removable plates, as may be seen from the illustration, and the crank webs are enclosed by a cast-iron hood having two holes with removable covers, one for the purpose of cleaning the crankpin box while it is in motion and the other for removing the box without taking off the large hood. Between the watershed partition and the front end of the cylinder is a hand-hole for reaching the stuffing box bolts without communication to the oil spaces.

There are two oiling system for this type of engine, the gravity or tank system and that by forced pump lubrication. With the gravity or tank system, shown in the illustration, an oil tank supplies the pipes leading to the parts to be oiled. At each point where the oil is delivered is a little gauge glass and valve for regulating the flow at that point. A valve just below the tank regulates the entire oiling system.

The generator of this set is of the eight-pole type, and is capable of carrying momentary overloads of 50 per cent. without any shifting of brushes or flashing of the commutator, and an overload of 25 per cent.

for a period of two hours without undue heating. After a continuous run of ten hours at full load, the increase in temperature above that of the surrounding air never exceeds 40° C. upon the armature and field coils, and 45° C. upon the commutator.

The average temperature rise is about 33° to 35° C. Before being shipped, the generator is given a break-down test of 1,500 volts, alternating, for sixty seconds between the conductors and the frame of the machine to test the insulation. The magnet frame is of the best grade of cast iron, split horizontally. The pole pieces are of wrought iron with cast iron shoes or horns, and are secured to the magnet frame by through bolts. Any of the pole pieces may thus be removed to repair the field coils.

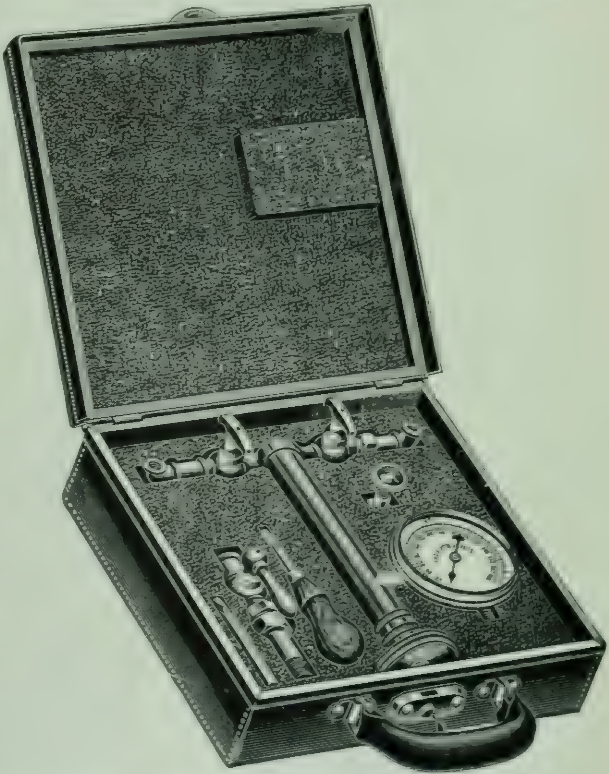
The armature is of the ironclad, form-wound, ventilated-drum type, having a core built up of charcoal iron plates, which plates after being thoroughly japanned are mounted upon a cast-iron spider and securely held in position by end flanges. No bolts pass through the armature laminations. The armature spider has an extension upon which is mounted the commutator, making the armature and commutator one unit. In the construction of the commutator, only drop-forge or drawn segments are used, these being secured in cast-iron shells of spider construction and clamped in place with a steel ring. Carbon brushes only are used, the commutator being so proportioned and the brushes of such size as to allow at least one square inch of brush area to every 30 amperes carried. These brushes are carried in holders of most approved construction, each mounted upon a self-contained brush rigging so arranged that the entire set of brushes may be rotated completely around the commutator.

Additional details concerning these generating sets will be supplied, on request, by the B. F. Sturtevant Co., of Boston.

Ashton Inspectors' Testing Outfit.

IN inspecting and testing work it seldom happens that all the necessary instruments are available at the plant, and even if they are there, it is better for the inspector to have his own, which he knows to be absolutely reliable.

For these reasons the outfit which is herewith illustrated will be found very tonvenient. It is particuarly designed to meet the requirements of boiler and power plant inspectors, mechanical engineers and chief engineers, as it is accurate, durable, of light weight and easily portable. The outfit consists of the following nickel-plated instruments: Three-inch standard test gauge, screw test pump, gauge hand puller, hand set, lever handle, union gauge cock and screw driver, all neatly and compactly contained in a velvet-lined leather case, fitted with lock and handle.



ASHTON INSPECTORS' TESTING AND PROVING OUTFIT.

The approximate weight of this outfit is eight pounds, and further information concerning it, as well as of their other products, will be furnished, on request, by the makers, The Ashton Valve Company, of 273 Franklin St., Boston, Mass.

Otis Feed-Water Heater, Oil Separator and Filter Combined.

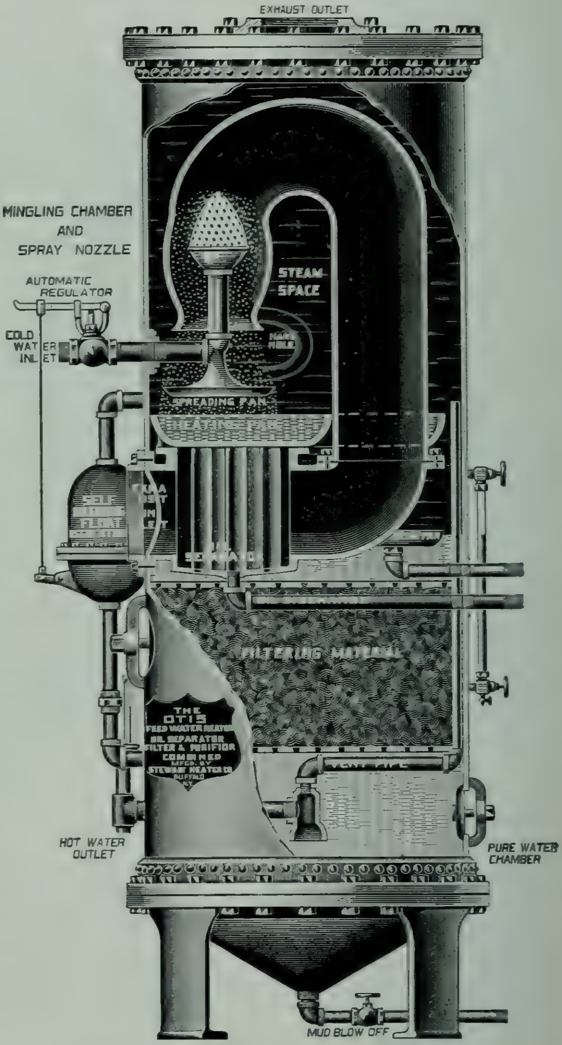
UPON the proper utilization of the exhaust steam and the purification of the feed water depend, in a large measure, the efficiency and proper operation of a steam generating plant, and so an apparatus which unites these functions is of especial interest.

Such an apparatus is shown in the accompanying illustration of the Otis feed-water heater, oil separator and filter combined. This heater consists of a steel shell with cast-iron heads, sustained by four cast-iron legs bolted to the conical bottom, thus making a substantial base for the heater.

The exhaust steam enters the heater at the side and passes directly into and through the oil separator, where the oil that is carried over with the exhaust steam from the engine cylinder is separated and passes out at the bottom of the oil separator through the oil discharge pipe. The exhaust steam then passes on into the mingling chamber or spray condenser, where it is brought into direct contact with the spray of cold water, and as the spray of cold water and exhaust steam cannot separate until they both pass out at the bottom of the mingling chamber together, the water is heated as hot as the exhaust steam. The exhaust steam then circulates freely through the steam space and passes out at the opening on top. This steam can be used for other heating purposes, if required, as all the water of condensation is deposited in the heater, and this exhaust steam will carry no water out with it. Therefore, no exhaust head will be required where this heater, oil separator and filter is used.

The feed-water pipe enters the side of shell, turns upward and projects into the mingling chamber, where it terminates in a conical spray nozzle.

The spray of water is thus brought into direct contact with the exhaust steam as it enters the heater, and becomes instantly heated; the heated water then falls upon the spreading cone, where it is again sprayed or spread into the heating pan and flows over its edges before it can mingle with the water in the heater.


EXHAUST OUTLET
MINGLING CHAMBER AND SPRAY NOZZLE
AUTOMATIC REGULATOR
COLD WATER INLET
STEAM SPACE
SPREADING PAN
FILTERING MATERIAL
THE OTIS FEED WATER HEATER OIL SEPARATER FILTER & PURIFIOR COMBINED MFGD. BY STEWART HEATER CO BUFFALO N.Y.
HOT WATER OUTLET
PURE WATER CHAMBER
MUD BLOW OFF

OTIS FEED-WATER HEATER.

The heated water is then in the proper condition to deposit the impurities, and as it passes down through the filter or filtering chamber, the clay, sand and other matter in suspension, the carbonate of lime and magnesia in solution are separated, and the pure water enters the pure-water chamber, which is of large capacity, to allow any particles of sediment that should be in the water to settle in the bottom, and it can be blown out at any time by opening the blow-off valve.

The supply of water to the heater is automatically controlled by the float and regulating valve, which keep the water at the proper level in the heater at all times.

The float is self-draining or unsinkable, the stem being a brass tube, so should there be any leak, the water could pass off through the stem and the float retain its buoyancy. These floats are made of copper and are tested to 200 pounds.

The float is placed in a separate chamber, attached to the heater shell at the top and bottom, so that any variation in the water level in the heater will cause the float to rise or fall, thus opening or closing the regulating valve, and keeping just the proper amount of water in the heater. The automatic regulating valve is a balanced valve, very positive in its action, and is operated with a very slight movement of the float.

The filtering chamber is very easy of access, and the filtering material can be removed when necessary and the chamber refilled in a few minutes. None of the scum or oil can get into the boilers, as the pure water is taken from the center of the water chamber. and the hot water or suction pipe to the pump is furnished with a vent pipe, so that should the supply of water be shut off and lower the water in the heater. the pump would stop pumping and prevent any of the scum getting into the boilers.

These heaters act well as an expansion tank to overcome the pulsation; and also as a receiving or condensation tank, for the water of condensation from the heating system in the building can be returned through them and again pumped to the boiler as pure water.

All of the exhaust steam should be passed through the heater, to extract the oil that is carried over from the engine cylinder before being used for other heating purposes.

The exhaust steam can then be used to good advantage in the heating coils, without filling them with oil and grease.

Thus these heaters not only heat the water to the boiling point, 212° F., but will automatically control the water supply, take all the sediment out of the feed water that can be taken out with the exhaust steam, and extract the oil from the exhaust, without the extra expense of an eliminator.

Further particulars regarding this apparatus may be obtained from the manufacturers, the Stewart Heater Co., of Buffalo, N. Y.

Weber Steel-Concrete Chimneys.

REINFORCED concrete, or concrete steel, as it is often called, has been making great progress as a structural material of late years, and from its early use in bridges it has been developed so that it is now employed for beams, columns, pipes, walls and buildings and structures of all kinds.

One of its more recent applications has been in the construction of chimneys, which has been carried to a high point of excellence by the Weber Steel-Concrete Chimney Company, of Chicago.

This company makes a specialty of building reinforced-concrete chimneys, among the advantages of which are the following:

They are monolithic, the whole chimney, from base of foundation to top. being one solid piece of concrete, reinforced by steel, and therefore almost indestructible. These chimneys are of the highest working capacity, because they are absolutely air tight, and the flue is almost perfectly smooth inside and has a uniform inside diameter. A Weber chimney can be erected in a shorter time than a brick or steel stack, and they take up much less room than a brick or self-supporting steel stack, which is a point of the utmost importance in a modern steam plant. A chimney of this kind is very light, even lighter than a self-supporting steel chimney, including lining and foundation, and the pressure on the ground is about one-fifth as much as in a brick chimney, so making possible the saving of a great deal of money otherwise spent for pile driving and other foundation work. A Weber chimney will resist the influence of the chimney gases and heat better than any other, and is capable of resisting a continuous heat up to 1,500 degrees F. without injury. Then these chimneys have a very handsome appearance, the light gray color of the chimney, in connection with the elegant and graceful outlines, giving an artistic effect that cannot be produced in a brick or steel chimney.

WEBER STEEL-CONCRETE CHIMNEY AT ZIEGLER, ILL.

A Weber steel-concrete chimney which has been built for the Ziegler Coal Co., at Ziegler, Illinois, is shown in the accompanying illustration. This chimney is 154 feet high and has an inside diameter of 6 feet. The total weight of this chimney, including foundation, is 556,090 pounds, and the base of foundation is 6 feet 6 inches below ground. The chimney consists of two distinct parts, the lower part having a double shell, while the part above the offset is single. The outer shell of the double part is 6 inches thick and the inner shell, which acts as a lining, has a thickness of 4 inches, the shells being divided by a circular air space of 4 inches. The single shell above the offset is 5 inches thick, tapering to 4 inches. The work for this chimney was commenced March 5th, 1904, and was finished and the chimney ready for use on May 1st. The chimney is built to withstand a wind pressure of 50 pounds per square foot, projected area, corresponding to a wind velocity of 100 miles per hour, which is much more than brick or steel chimneys are usually calculated to resist. All the work was done from an inside scaffolding and ladder, and no outside scaffolding was used for the construction of the chimney. A large number of these chimneys have been built by the Weber Company, who now have under construction a chimney 300 feet high and of 18 feet inside diameter for a large smelting plant in the West. After completion, this chimney will not only be the largest concrete chimney ever erected, but will also be one of the largest chimneys in the country, only a very few exceeding it in diameter or height. A Weber chimney already built for the Burt Portland Cement Co., at Bellevue, Mich., is 182 feet high and 8 feet in diameter.

The Weber Steel Concrete Chimney Co., of Chicago, will be pleased to supply further information concerning these fine structures.

Howard Watchman's Clock.

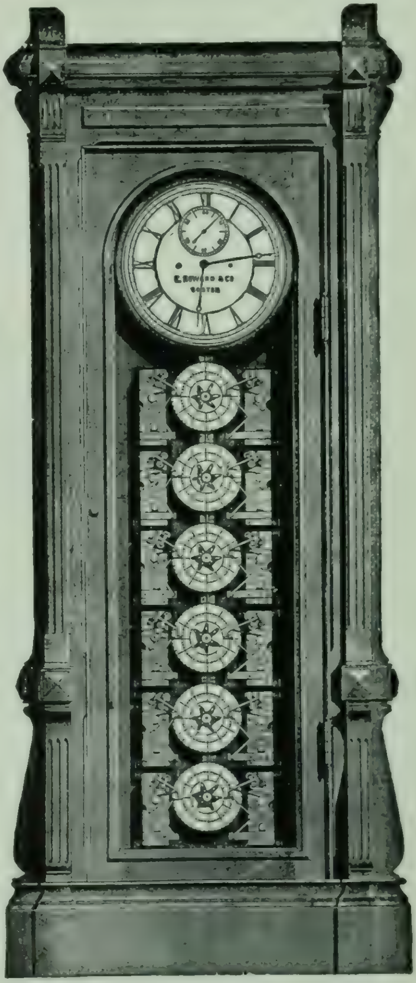
NO matter how faithful a watchman may be, it adds to his efficiency and to the feeling of security enjoyed by his employer if a definite record can be made which will show without question that he has performed his duty properly.

Such a record may be obtained by the use of the Howard electric watchman's clock, which has fully demonstrated its value by a long term of successful service, improvements having been added from time to time to keep it entirely up to date.

In the Howard system the record is made on a circular sheet of paper in the clock by means of needles actuated by electromagnets. The current is furnished by a primary battery, and is led through a two-wire circuit, which includes the clock and all the stations that the watchman is to visit, the stations being connected in parallel. Each station makes its distinctive record, which cannot be mistaken for any other.

It is not necessary that the boxes or stations be visited in any particular order or an equal number of times, for the record of each box is given independently of any other, and the route of the workman may be changed, the record showing just what course he has taken. When a watchman reaches a station he inserts his key, which fits all stations alike, and gives one full turn, after which the station automatically makes the record by allowing the electric current to pass through contact pieces which are different for every station, and so making a distinctive record at the clock where the time of the record is also shown on the paper dial. This system does not require that the watchman should be at a given point at a stated time, as each station may be recorded at any time.

A new needle has recently been designed for the Howard clock, for perforating the paper dial when the watchman registers. In some large buildings the watchman must make a hurried round, a practice which the Howard Company discourage when possible, because the greatest efficiency on the part of the watchman cannot be obtained when he goes too rapidly from one station to another. But as such instances do occur, the company have made a change in the registering device of their clocks. The blunt point ordinarily used with their apparatus does not penetrate the paper, but indents it, spreading the texture, so that when stations are rung in rapid succession the indentures run one into the other, making it difficult to read them. The Howard system enumerates the stations by punctures:—that is, No. 1 station registers one puncture; No. 5, five punctures; No. 14, a puncture, a wide space, and then four punctures close together—a great advantage of this being that no watchman could accomplish the registration of a box, otherwise than from its station, by getting track of the wires and causing a contact. He could register, but he could not space as the mechanism spaces, and any



HOWARD CLOCK FOR TWELVE WATCHMEN.

such attempt would be easily detected. But with a blunt point when two stations are registered in rapid succession the two merge on the dial. The substitution of a sharp needle, which perforates the paper instead of indenting it, obviates this difficulty, because it is easy to read the registration of the dial even when the stations are rung within a minute of one another, or even less.

The clock has so little to do in fixing the time of the records that its timekeeping qualities are in no way impaired, and it can be relied upon to maintain standard time. A clock can be fitted to accommodate any number of watchmen, the one shown in the illustration being arranged for twelve, its capacity being only limited by the space reserved for it. Any number of stations can be added to or removed from the system without interfering with those remaining. Any one may have free access to the clock, and still a record made in any other way than that intended will surely be detected. The cases are made in the most thorough manner, the doors setting in a rabbet and being provided with a Yale lock. When desired, a recorder is attached which prevents the door from being opened without making a record on the dial.

The record of the watchman's rounds is a permanent one and cannot be erased, as it is made by punctures through the recording dial, which can be filed for future reference. This is of decided importance when a reduction in rates of fire insurance is under consideration.

The clock may be placed in the office or in any building near to or remote from the watchman's territory, two wires, only, running from the clock through the building, being necessary for any number of points which the watchman is required to visit on his rounds. This makes the wiring very simple, and facilitates the placing of additional stations, as may be desired.

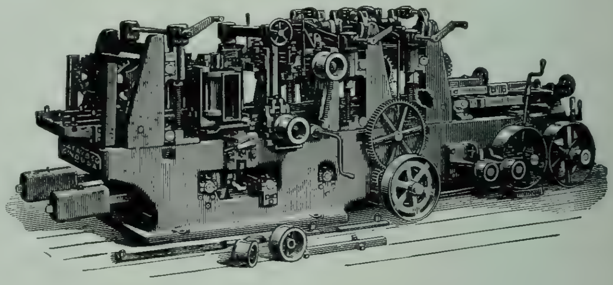
The E. Howard Clock Company, of 401 Washington St., Boston, Mass., will be pleased to furnish further information concerning this system.

Double Cylinder Planer, Matcher and Jointer.

A NEW heavy six-roll, double-cylinder planer, matcher and jointer, which has lately been brought out by a large manufacturer of wood-working machinery, is shown in the accompanying illustration.

This is one of the largest and heaviest combined planers and matchers built, and is especially useful for car building and repair shops, and large lumber mills.

It will plane to 30 inches wide and 14 inches thick, and will work simultaneously three sides of two pieces of material of uneven thickness up to 12 inches wide and 14 inches thick. The frame is massive, perfectly jointed and bolted, so as to insure rigidity and freedom from vibration. The steel cylinders are slotted on all their faces, and have chip breakers for working cross-grained or knotty lumber. The matching works are very substantial and of improved construction, and are fitted with a patent weighted matcher clip for producing an even pressure on the material.



J. A. FAY & EGAN PLANER, MATCHER AND JOINTER.

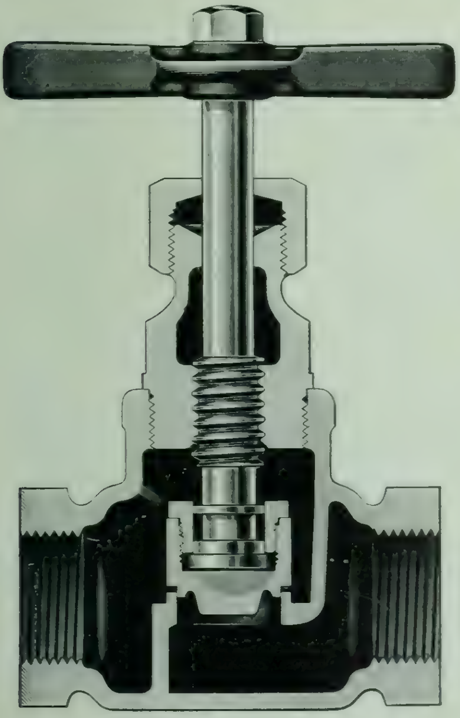
The feed works are very powerful, consisting of six driven rolls, which are easily raised and lowered, and are heavily weighted. The rolls are divided, have accurate adjustments and are always kept in true alignment. The feed is powerful, steady and uniform, and its rate can be furnished as desired.

This machine will be found to possess many other devices for facilitating the work and making the several adjustments, and further particulars can be obtained from the makers, J. A. Fay & Egan Co., of No. 212 to No. 232 W. Front Street, Cincinnati, Ohio, who will also send free to those interested their new illustrated catalogue of wood-working machinery.

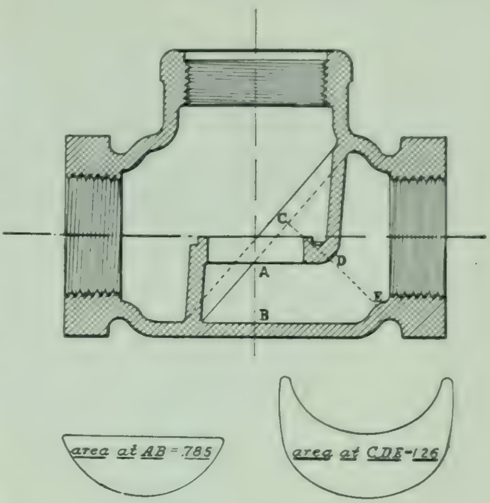
The Hancock Valves.

THE Hancock globe, angle, 60° and cross valves are made after the same general design as the Hancock main steam valves, used on locomotives for a number of years and found to give perfect satisfaction with the high steam pressures carried. These valves have been designed so that the metal is distributed to give uniform strength throughout and the areas have not been reduced or contracted for the purpose of reducing the weight, and from the illustrations of a globe valve shown herewith it will be seen that the area of the most contracted part of the valve is ample and of full size.

Attention is called to the way the valve is guided on the stem. An inspection of the section of this valve will show two collars or guides upon the stem which guide the disc nut, thereby compelling the disc to always seat squarely and absolutely preventing it from cocking. The valve seat is flat, which form has many advantages over any other used in valves of this character. The valve disc has a projection on it which serves two purposes. In the first place it acts as a guide when the seat is ground, and in the second place, this lip or projection on the disc prevents the cutting of the seat by the wire drawing of the steam when the valve is cracked or slightly open.



HANCOCK GLOBE VALVE.

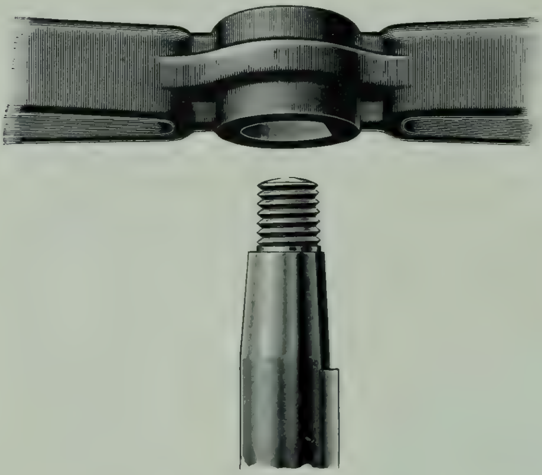


SECTION OF HANCOCK GLOBE VALVE, SHOWING AMPLE AREA.

Again, when the valve is slightly raised from its seat, with the lip entering slightly, it allows the escaping steam to clean the seat, so that when the valve is seated again all dirt and foreign matter has been washed or blown completely off the seat. This is a most important feature, as experience has fully demonstrated that when the Hancock valve begins to leak it requires a very little regrinding to make it tight. This is accomplished so easily that a tight valve can be maintained for a long time with extremely little labor and expense.

The bonnets of these valves are made with a long thread engaging the body of the valve, and the shoulder on the bonnet is made narrow. By means of this narrow seat on the shoulder, it is possible to keep the bonnet tight, and when it is desired to unscrew the bonnet, it can be easily done. This is a decided improvement over the form of bonnets having a wide shoulder bearing upon a wide surface on the top of the body of the valve.

When it is necessary to regrind the valve to its seat, the bonnet is removed and the disc nut unscrewed from the disc, and a piece of wood can be inserted in the disc, enabling it to be ground perfectly as the projection on the disc guides it, it not being necessary to have any special regrinding tools for this purpose.



TEE HANDLE OF HANCOCK VALVE.

The tee handle on the Hancock valve has proved to be so much more efficient in opening and closing that it has become popular among the users of these valves, and the demand is so universal that all valves sent out are equipped with the tee handle. Its advantages are especially apparent on steamships, where there are a multiplicity of valves and economy of space is necessary.

The illustration shows the peculiar method of attaching the tee handle. The hole in the handle is made tapering with one side flat, and the spindle of the valve is also made tapering with one side flattened to receive the handle, the tee handle being held on the spindle by means of a nut. The flattened side holds the handle rigidly in its place, and the taper enables the handle to be drawn tightly to the spindle, so entirely avoiding the great annoyance of the handles or wheels working loose, which happens when they are attached by the old means of a square only.

In order that the valve seat may be hard and durable, the body is made of a specially hard and tough mixture. The discs are made of a special mixture which does not contain any zinc. The spindles are all made of Tobin bronze, experience having demonstrated that a Tobin bronze spindle working in a special composition bonnet will not cut under the highest steam pressures.

The Hancock globe, angle, 60° and cross valves are made screwed and flanged in sizes up to 3 inches, and are of one standard only, for all pressures. Under actual test, the bodies of these valves will stand a pressure of 4,000 pounds per square inch without breaking, and it is guaranteed that each and every one of them has been tested with 1,000 pounds water pressure and found tight before leaving the manufacturer's works, and that they will stand 500 pounds steam pressure.

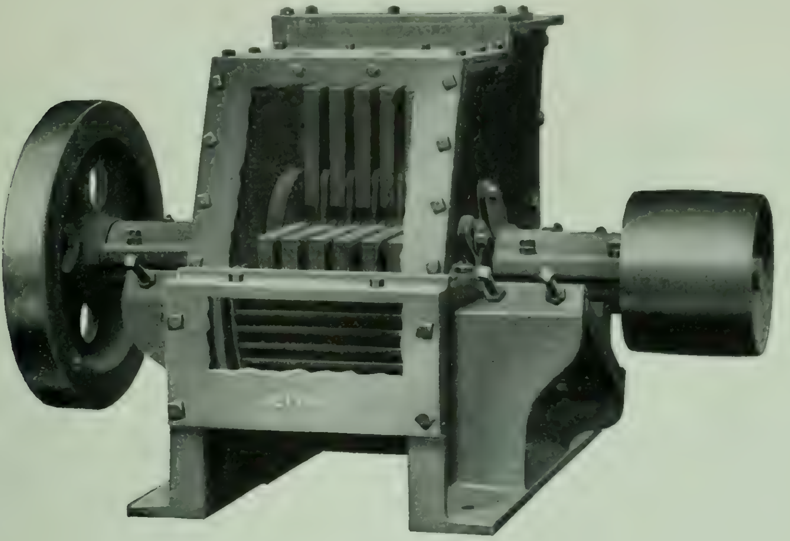
These valves are made by the Hancock Inspirator Co., whose general office and salesroom is at 85-87-89 Liberty Street, New York, and who will be pleased to supply further information on request.

Jeffrey Hammer Pulverizer.

THE manufacture of the hammer type of pulverizer has recently been taken up by the Jeffrey Manufacturing Company under the Schoellhorn-Allbrecht patents. One of the accompanying illustrations shows the pulverizer with its interior or crushing parts; the other shows the sectional screen frame, which is one of the special features in this machine.

This pulverizer is designed for crushing and pulverizing substances such as coal, clay, shale, rock, and many other materials, and it is claimed to be the simplest machine of its kind made. Among its strong features are its simple beater hammer, its "V" shape bar screening surface, its simple adjustment of the beater arms to accommodate wear, its substantial dust-proof pillow blocks, and its top-feed hopper, which insures large capacity and permits material to be partly crushed while in suspension.

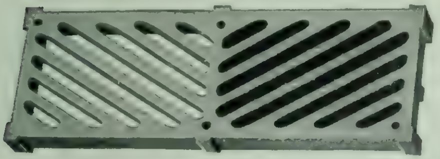
The accessibility of its inner parts is also one of its strong points. The taking off of the rear plate and the hand-hole plates on



JEFFREY HAMMER PULVERIZER.

the side of the machine make it possible to change the beater arms as well as the screening when necessary. The screening surface is made up in sections, so that it is the work of but a few moments to take out or change from one size mesh to another.

Many of these machines are in use, so there is no experimental period to be gone through with. This pulverizer is made in many sizes to suit the various requirements; for instance, in coal the capacity varies anywhere from fifty to one hundred tons of coal per hour, depending entirely upon the degree of fineness. In pulverizing material such as rock its capacity is anywhere from ten to twenty-five tons per hour.



SECTIONAL SCREEN FRAME OF JEFFREY HAMMER PULVERIZER.

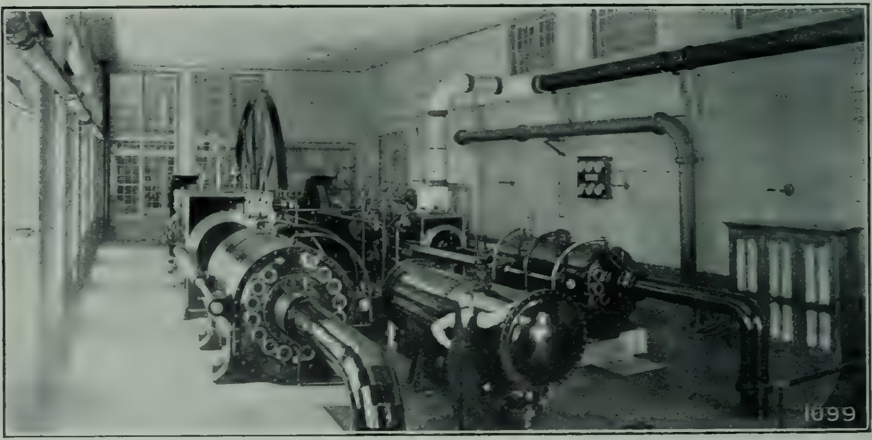
The Jeffrey Company make free crushing tests for interested parties, thus demonstrating, before sale, what the machine is capable of doing. Complete catalogue on this subject can be had by addressing the Jeffrey Manufacturing Co., Columbus, O.

The Air Compressor Plant of the Homestake Mining Company.

COMPRESSED air has long been recognized as a powerful factor in economical mine operation, and in the Homestake Mine, at Lead, South Dakota, its possibilities have been developed to the utmost. As is eminently fitting, this mine, which is said to be the greatest gold producer in the world, has in its power plant the largest air compressor in the world, and this giant must receive the first mention in the list of machines on the Homestake lode. It is located at the Ellison shaft and is a cross-compound condensing two-stage Corliss machine, built by the Ingersoll-Sergeant Drill Company. The high- and low-pressure steam cylinders have a diameter of 32 and 60 inches, respectively, the air cylinders are 52¼ and 32¼ inches in diameter, and the stroke is 72 inches. At rated speed of 50 revolutions per minute. the free-air capacity is 9,000 cubic feet per minute, this volume being sufficient, under average conditions of mine work, to operate 125 rock drills. The steam pressure is about 130 pounds. The exhaust steam is received by a Wheeler surface condenser, in connection with a cooling tower. The well-known Ingersoll-Sergeant piston inlet valve is used on both high- and low-pressure air cylinders, between which a horizontal intercooler is placed in the air circuit. The total weight of this huge compressor with its accessories is about 300 tons. It is placed beside the great Ellison hoist, the mountain being blasted out to make space for the engine room.

The output of this great machine is used exclusively for operating machine drills in the underground workings, and it is assisted by two smaller machines, built by the same maker and both of Corliss type, with piston inlet valve. One of these machines, located at what is known as the Old Abe shaft, is a duplex machine, with steam cylinders 24 inches in diameter, air cylinders 26¼ inches and a stroke of 60 inches. Its capacity in free air is about 4,400 cubic feet per minute. The other compressor is at the Highland shaft, and is of the same type as that just described. Its stroke is 42 inches, the air cylinders are 22¼ inches and steam cylinders 20 inches in diameter. At rated speed its free air capacity is about 2,600 cubic feet per minute. These two compressors, together with the giant at the Ellison shaft, are operating over two hundred Ingersoll-Sergeant rock drills in the mine workings.

In the hoist room at the Ellison shaft, not far from the largest compressor, is installed a small Ingersoll-Sergeant Class "GC" compressor, with duplex steam cylinders and two-stage air end. This is one of the smallest machines equipped with the piston inlet valve, and the contrast between it and the large machine adjacent is striking. The smaller machine has a stroke of 12 inches, its steam cylinders are 10 inches in diameter, high-pressure air cylinder 10¼ inches in diameter, low-pressure 16¼ inches. At rated speed of 160 revolutions per minute the piston displacement is 444 cubic feet of free air per minute. The air from this compressor is used in the cylinders controlling the starting, stopping, reversing and braking of the Ellison hoist. In this engine room is located a straight-line high-pressure compressor of the same make furnishing air at 900 pounds pressure to charge the storage tanks of a locomotive used in hauling ore cars between shafts and mills in the surface workings.



INGERSOLL-SERGEANT AIR COMPRESSOR AT HOMESTAKE MINE.

For various purposes in the mills and surface workings two other air compressors of Ingersoll-Sergeant make are installed. These are both of Corliss type, with piston inlet valves. The sizes of these machines are 12 and 16¼ inches, with 36-inch stroke, duplex type, and 12 and 18¼ inches by 36 inches, half duplex. Their combined capacity in free air is about 2,100 cubic feet per minute.

Further particulars regarding this interesting plant may be obtained from the Ingersoll-Sergeant Drill Co., of 26 Cortlandt Street, New York.

NEWS SUPPLEMENT

The Engineering Magazine—February, 1905

Personal.

—J. U. Jones, of Dallas, Texas, has joined the staff of the Allis-Chalmers Co., Milwaukee, and will hereafter represent them in Texas and its tributary territory.

—W. L. Loveland has been appointed manager and H. Schifflin assistant manager of the mining and crushing department of the Allis-Chalmers Co., with headquarters in the New York Life Building, Chicago.

—C. W. Whitney has resigned as Pacific Coast representative of the McGraw Publishing Co., New York, and has taken charge of the publicity department of Abner Doble Co., San Francisco, engineers and manufacturers of tangential water wheels and needle regulating nozzles.

—Henry C. Mortimer, Jr., of the General Electric Inspection Co., has joined the New York office staff of the Crocker-Wheeler Co. He will assist F. B. DeGress, manager of that office, and will succeed A. J. Thompson, who has accepted a position with the New York branch of the Bullock Electric Manufacturing Co.

—Henry S. Manning has sold to Charles A. Moore his entire interest in the firm of Manning, Maxwell & Moore, together with his interest in the Ashcroft Mfg. Co., Consolidated Safety Valve Co., Hayden & Derby Mfg. Co., and Hancock Inspirator Co. There will be no change in the name or character of the firm and its business in the future will be conducted by Mr. Moore and the men who have been associated with him.

—W. S. Montgomery, for many years sales manager for the Conover Condenser Co., and for the past year New York manager for the Payne Engine Co., has formed a partnership with G. M. Rogers under the firm name of Rogers & Montgomery, with offices at 147 West 23rd St., New York. The new firm will deal in a general line of small labor-saving tools, and are the exclusive United States sales agents for the new line of hand and press punches lately brought out by the Gem Tool Works of Brooklyn.

Industrial Notes.

—The annual meeting of the American Institute of Mining Engineers will be held Feb. 21, at 99 John St., New York.

—The Electric Controller & Supply Co., Cleveland, has placed George Magalhaes in charge of its eastern office at 136 Liberty St., New York.

—The Bristol Co., Waterbury, Conn., was awarded a gold medal for an exhibit of recording instruments at the St. Louis World's Fair.

—Chicago Pneumatic Tool Co., Chicago, has received a cablegram from their London branch for 705 tools. This is an indication that their business abroad is growing.

—On account of the rapid growth of its business, the Pittsburg Gage & Supply Co., Pittsburg, Pa., has leased another store and warehouse adjoining their present location. The building is four stories, 50 x 200 feet.

—Goldschmidt Thermit Co., New York, at the request of the United States authorities, has presented to the National Museum at Washington, its entire exhibit at the World's Fair, St. Louis.

—The F. W. Braun Co., Los Angeles, Cal., was awarded gold medals by the World's Fair, covering practically their entire line of apparatus and appliances for assayers, metallurgists and chemists.

—Missouri Pacific Railway runs a train between St. Louis and the City of Mexico that saves over nineteen hours. It leaves St. Louis every day at 2:21 P. M. and arrives at the City of Mexico at 10.50 A. M. the third morning.

—Brown Hoisting Machinery Co., Cleveland, has issued a set of illustrated cards, printed in colors, describing in simple language, for the non-technical, sixteen important types of cranes manufactured by them.

—Brown Corliss Engine Co., Corliss, Wis., has received the contract from the city of Milwaukee to furnish and erect complete, at the North Point pumping station, one triple expansion high duty crank and fly wheel 20,000,000-gallon pumping engine.

—The engraving and steel stamp business of the Schwerdtle Stamp Co., and the rubber stamp business of the Bridgeport Stamp Co., have been consolidated, and will hereafter be known as the Schwerdtle Stamp Co., with offices at Bridgeport, Conn.

—Diamond Drill & Machine Co., Birdsboro, Pa., has opened a New York office at 52 Broadway. Their steel and iron foundries are busier now than at any time during the past year, while their machine shop is running double, being especially busy on rolling mill and blast furnace work.

—The National Electric Co., Milwaukee, was awarded the contract for equipping with air brakes the new convertible type of cars of the Cleveland electric railway. This is the largest contract for individual air brake compressors that has ever been placed in this country.

—Isthmian Canal Commission, Washington, are inviting proposals for machine tools, machinery, hand cars, leather belting, rope, canvas and rubber hose, cars, and miscellaneous supplies, including coal tar, axle grease, glue, ticking, horse hair, etc. Copies of the proposals may be had upon application to the commission.

—Brown Corliss Engine Co., Corliss, Wis., has received an order from the Illinois Steel Co., for a 2,000 horse power combined vertical and horizontal Corliss engine to be established at their Joliet plant. This engine is similar in design to the engine exhibited at the World's Fair by Allis-Chalmers Co.

—The Illinois Steel Co., Joliet, Ill., is about to begin an extension of its works, at a cost of $100,000, to accommodate the business of the Continuous Rail Joint Co., of America, Newark, N. J. The latter company has extensive works at Troy, N. Y., but its western business requires a plant nearer the center of trade.

—The California Gas & Electric Corporation, San Francisco, has just ordered from the Stanley Mfg. Co., two frequency changing outfits of 5,000-kilowatt capacity each, amounting to virtually 20,000-kilowatt capacity divided between four machines operated as two motor generator sets. The contract also includes transformers of 1,000 kilowatts.

—The Erie Railroad, through its Industrial Department, has issued a map of its system, which shows, in graphic style, the many admirable locations for manufacturing, mining and other industries along its line. Full particulars regarding this department of the Erie Railroad may be obtained from its Industrial Commissioner, Mr. Luis Jackson, 21 Cortlandt St., New York.

—The Electric Controller & Supply Co., Cleveland, has just shipped the second of two 200 horse power 220-volt type M. T. magnetic switch controllers to the Lorain plant of the National Tube Co. They are for the control of the reversing motors driving the tilting tables on each side of the plate mill. Other shipments of controllers of this type have been made recently to the Carnegie Steel Co., the Lackawanna Steel Co., and the Illinois Steel Co.

—The Allis-Chalmers Co. opened new sales offices in Philadelphia on January 1st in the Land Title Building. The offices heretofore maintained by the electrical department of the company, the Bullock Electric Mfg. Co., in the North American Building, have also been removed to the Land Title Building, where they have been consolidated with those of the parent company. The new offices are in charge of W. A. Wood.

—The following concerns are among those who have recently equipped their power plants with the White Star continuous oiling system installed by the Pittsburg Gage & Supply Co., Pittsburg: Portland Electric Light Co., Portland, Ore.; Peoples Power Co., Moline, Ill.; Watson, Jack & Co., Montreal, Can.; Diebold Safe & Lock Co., Canton, O.; Robb Engineering Co., Amherst, N. S.; and Suffolk Light & Ice Co., Suffolk, Va.

—The Westinghouse Electric Manufacturing Company's "Diary" for 1905 is lifted into a class quite above that of most publications of the kind by the fact that in addition to the general tables of useful data, equivalents, and formulæ, it contains a special section of "Engineering Data for Electrical and Mechanical Engineers." These cover the subjects of electric railways, motors for machine-tool drive, illumination, power transmission, lightning arresters and choke coils, operating hints on electrical machinery, first aid to the injured, steam boilers and heating value of coal, commercial power gases, and the performance of gas engines and steam turbines. The convenient and compact presentation of the material make the diary a serviceable pocket reference book.

—The Wellman - Seaver - Morgan Co., Cleveland, was recently awarded contract to construct two large coal handling machines for the Boston Coal Dock & Wharf Co., Duluth, Minn. This is one of the docks under the management of the St. Paul & Western Coal Co. The machines consist of two conveyor bridges, each about 350 feet long, including front and rear cantilevers, and are designed so that coal may be screened and loaded into box cars as well as unloaded from vessels, built to be operated by steam. They will be equipped with 2-ton Hulett excavating buckets, and machinery designed to give maximum speeds of operation. The structural work will be of steel throughout, and the machines will be self-propelling along the dock.

—The Shepherd Engineering Co., Franklin, Pa., report recent installations of their engines as follows: Eberhard Faber Pencil Co., Brooklyn, one 600 horse power, four valve, cross compound engine; two 250 horse power, each direct connected to two generators installed in the Russia Building, Boston; one engine direct connected to Crocker-Wheeler generator, at Fort Andrews, Boston Harbor; two engines for Brandon Hall, Beacon Hill, Boston; three engines for the new office building, Columbus Savings & Trust Co., Columbus, Ohio; two engines to the Arbuckle-Ryan Co., Toledo, Ohio, for installation at the plant of the Northwestern Ohio Bottle Co.; and one engine to the Joyce-Cridland Co., Dayton, Ohio. They have also been awarded the gold medal for their engines at the St. Louis World's Fair.

—Westinghouse Electric & Manufacturing Co., Pittsburg, has closed the following contracts: International Paper Co., Berlin, N. H., one 250-kilowatt alternating current generator of the revolving armature type, and three 40 horse power alternating current motors, with switchboard, transformers etc.; Detroit United Railway Co., Detroit,, one 1,500-kilowatt railway generator and a 250-kilowatt booster set. Other street railway contracts just closed include 50 four-motor car equipments, to be used by the Cleveland Electric Railway Co., Cleveland. Syracuse Railroad Construction Co., two 1,500-kilowatt turbo-generator outfits which will generate current at 3,300 volts, 3-phase and 25 cycles. Each turbo-generator will be furnished with a 50-kilowatt exciter mounted on the turbine shaft, two 500-kilowatt rotary converters and six 400-kilowatt rotary converters; twenty-four transformers, with a total capacity of 6.500 kilowatts, a 13-panel switchboard for the main generating station, and three sub-station switchboards of five panels each. Motor equipments included in the contract call for twelve quadruple equipments of Westinghouse 110 horse power motors, as well as eight quadruple and two double equipments of motors of other sizes; Ontario Power Co., for an alternating current generator with a rated output of 10,000 horse power at 85 per cent. power factor. This is in addition to three other machines of similar type for use in furnishing this plant. The generators are of the revolving-field, two-bearing type, designed for direct connection to water-wheels; they generate 3-phase current at 12,000 volts and 25 cycles, and run at a speed of 187½ revolutions per minute. Among other apparatus included in the contracts are twelve 30,000-kilowatt oil-insulated water-cooled transformers, wound for 12,000 and 60,000 volts; two 375-kilowatt exciters, and complete switchboards. They have received through Takata & Co., Tokio, their Japanese agents, contracts for 13 direct current generators, each of 52.5 kilowatts capacity and 13 spare armatures. Each generator will be driven by a 125 horse power steam engine, and the 13 engines will be supplied by the Westinghouse Machine Co. Turbo-generator contracts closed include two 1.000-kilowatt outfits for the Haverhill (Mass.) Electric Co., to be used in lighting and power work; two 1,500-kilowatt outfits for the Rochester, Syracuse and Eastern Railroad, and one 1.000-kilowatt outfit with exciter for the Springfield (Mass.) Electric Light Co.; also a 300-kilowatt turbo-generator with exciter for the Northern Electric & Manufacturing Co., Montreal. The Springfield Electric Light Co.'s contract also included two 500-kilowatt rotary converters and four 300-kilowatt transformers.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Air Compressors.

Catalogue No. 35 consisting of advance sheets of Catalogue No. 36, and includes some information additional to that appearing in the first edition of No. 35. There are views of several important new installations, including those of the Cleveland Stone Co., and at the Mare Island Navy Yard. Air receivers, inter- and after-coolers are also given a place. The complete catalogue No. 36 will appear later. 7 by 10 in.; pp. 100. Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

Pamphlet, illustrating and describing an extensive line of air compressors and vacuum pumps. More than twenty-one types of machines are shown. The range of sizes includes machines displacing from two cubic feet of free air per minute to those having a capacity of 1400 cubic feet. 6 by 9 in.; pp. 48. Clayton Air Compressor Works, New York.

Leaflet, containing description and illustrations of air compressors. 4¼ by 8¼ in.; pp. 6. Norwalk Iron Works Co., So. Norwalk, Conn.

Centrifugal Pumping.

A reprint of the paper by Professors J. E. Denton and William Kent, giving full details of the notable tests recently made by them of the De Laval Centrifugal pumps. The efficiencies obtained in these tests are said to rank above any ever before authentically recorded; and the high authority of the engineers in charge makes the pamphlet a very valuable one. Fully illustrated. 24 pp.; 6 by 9 in. De Laval Steam Turbine Company, Trenton, N. J., U. S. A.

Centrifugal Pumps.

Catalogue A 1, devoted to high-grade improved centrifugal pumping machinery, with illustrations of different types, tables showing sizes, capacity, horse power, weight and prices. 3¼ by 6 in.; pp. 30. Lawrence Pump & Engine Co., Lawrence, Mass.

Dry Steam.

A 60-p. pamphlet, 6 by 9 in., specifically designed to emphasize the necessity for employing dry steam in order to obtain the maximum of economy, efficiency and safety; together with an exposition of the various methods employed, and maintaining the superiority of the system of "mechanical" separation, as demonstrated in the Stratton Separator. The Goubert Manufacturing Company, 85 Liberty Street, New York, U. S. A.

Electric Hoists.

The Sprague Electric Co., 527 West 34th Street, New York, have issued a beautifully illustrated pamphlet, 9 x 12 inches, presenting numerous diagrams and detailed photographic views of the now celebrated Sprague Electric Hoists. A fine specimen of the modern printing art as applied to the practical needs of the Engineer, the Superintendent, and the Manager.

Lamps.

Pamphlet, describing street lighting by Nernst lamps in Berwyn, Ill. 3½ by 6¼ in.; pp. 12. Nernst Lamp Co., Pittsburg.

Mine Fans.

A 12-page pamphlet, 6 by 9 in., illustrating and describing the "Stine" fans, which, since 1895, have been so widely introduced throughout the mining regions of the United States. Authentic details as to the actual performances of the fans are given, together with a list of those who have adopted them. S. B. Stine & Son, Osceola Mills, Pa., U. S. A.

Mining Machinery.

Catalogue for 1905, profuse in its illustrations of the mining machinery handled (especially of crushers and hoisting and winding engines), together with many valuable tabular exhibits indicating dimensions, capacity, etc., etc. 8 by 10 in.; pp. 140. Earl C. Bacon, Engineer, Havemeyer Building, New York, U. S. A.

Mond Gas.

An admirable publication, 106 pp.; 8 by 10 in., fully describing the origin, processes, and machinery of this modern source of power for gas producer plants. The wide range of applications is remarkable, and the publication is one which every up-to-date engineer, superintendent and manager should have at hand for reference. R. D. Wood & Co., Philadelphia, Pa., U. S. A.

Rock Drills.

Rock Drills and Drill Mountings is the title of an admirable pamphlet of 80 pages, issued by The Rand Drill Co., 128 Broadway, New York. It opens with an authentic history of the development of the rock drill by the late Addison C. Rand, followed by numerous and beautiful illustrations of modern drills now in use for all purposes, together with tabular exhibits clearly indicating the performances of all the various types of drills in some of the most important mining and tunneling work done in recent years. A pamphlet which every engineer should have at hand for reference purposes.

Steam Pumps.

Catalogue for 1905, illustrating and describing in detail a great variety of pumps for different service made by this firm. Few modern catalogues that come to us for notice present so much valuable information in detailed and accurate form as this one. It is a model in size, convenience of arrangement, orderly presentation of valuable information beautiful illustrations, and intelligent introductory matter, indicating to purchasers all the facilities of the firm in meeting their exact requirements. 6 by 9 in.; pp. 150. A. S. Cameron Steam Pump Works, New York, U. S. A.

IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Jessop's High-Speed Steel.

THE ever-present problem of increasing manufacturing capacity and efficiency has brought about a widespread interest in high-speed steel. Although a comparatively new development in tool steel making, this product is now far past the experimental stage, and must be reckoned with by every manufacturer who aims to keep abreast of the marvelous progress that has been made in the manufacture of machine tools during the past decade.

But in adopting a brand of high-speed steel for his particular purpose, the manufacturer must use as great care as in selecting carbon steel—since the composition and working properties of each brand differ, and give very different results.

In every quality necessary to the production of high-speed tools, Jessop's "Ark" high-speed steel has fairly won a preeminent rank. This celebrated firm (established in 1774) claim to have improved upon all existing methods of producing this grade of steel, and now offer an article that gives truly astonishing results—because the tools can be operated at three to five times regular speed. In fact, there are few lathes that can be worked fast enough to do full justice to this steel.

The tools "stand up," and no matter how hot they may become, they will go right on cutting without danger of injury to the steel.

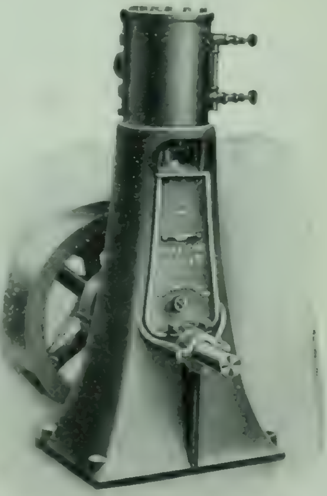
Jessop's "Ark" high-speed steel is guaranteed to be of uniform quality—it never varies. Results obtained to-day can be obtained to-morrow or next week. It is equally good for light or heavy work—from the largest milling cutters to small tools in holders.

The firm invites inquiries regarding the working properties of steel for any given purpose; and they carry a full stock of this steel at the main warehouse in the United States. Address Wm. Jessop & Sons, Ltd., 91 John Street, New York.

"A B C" Vertical Engine with Automatic Lubrication.

THE illustrations presented herewith show a new vertical steam engine which possesses unique features of merit. It is fully enclosed, thus preventing foreign matter from getting into the working parts, yet the latter are easily accessible upon the removal of the enclosing plates, by simply turning a milled hand nut and lifting out.

The most remarkable feature of the engine is its oiling system. Automatic lubrication of engines has been one of the details very slow in development. Up to the present time it has been confined almost



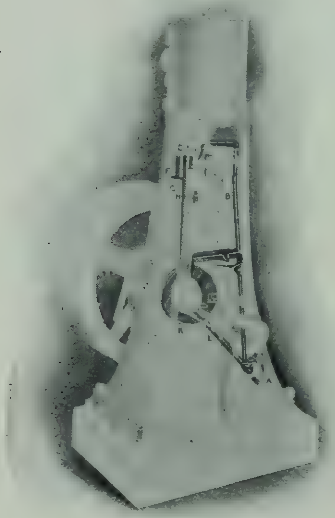
"A B C" VERTICAL ENGINE.

entirely to the splash system, which is seldom thoroughly effective, and for vertical double reciprocating engines is often unreliable.

Such attention as this detail has received has been applied to large horizontal engines, which are less likely to prove annoying through defective lubrication than are the small high-speed, vertical engines.

In this engine frictional surface runs in oil, there being no positive contact between metals.

The oiling is done by the engine itself, and instead of a drop or two a minute each bearing has a stream of oil. By referring to the "phantom" illustration the operation can be easily traced. An eccentric K on the shaft actuates the plunger L of the oil pump A, forcing the oil up through the tube B into the small strainer C. From C it drops into an oil box through the bottom of which four tubes project. In one side of each of these tubes there is a slot, so that when the oil box contains only a small amount of oil, each tube can take its proper proportion. If the box is full all the tubes get more oil in proportion to the increased height.



PHANTOM VIEW "A B C" ENGINE.

Two of these tubes, F and one on the opposite side, not lettered, apply oil to the crosshead guides, the oil dropping into a small oil trough G, from which it runs into the bearing through a small oil hole. The crosshead pin is supplied by the tube marked E; the oil drops into the cup H and fills the cavity between the bolt and inside of crosshead pin and the oil grooves. The oil dripping from the crosshead is caught in two pans attached to the inside of the covers. From these oil pans it runs down the inside of the cover, dropping into a cup in the top of the main bearing cap. Instead of oil grooves at the top and bottom of the main bearing, as ordinarily made, in this system the bearing is cut away at the joint. When the train from the connecting rod is up, the oil is carried to the bottom of the bearing; but when the load is reversed, there are no oil grooves to carry away this oil. The crank pin is oiled through the tube marked D. This tube discharges into a crank oil ring inside the eccentric K which in turn discharges into the crank-pin oil tube, and flows across the crank-pin bearing. The crank-pin oil ring in addition to its independent supply catches the drip from one end of the main bearing. The eccentric is oiled by the drip which it catches from the other end. Not the least difficulty has been experienced in catching the oil thrown off the eccentric strap and the splash from the crosshead has been equally easy to take care of, the outside of the engine being absolutely free from oil. A portion of the oil as it drips back into the bottom of the frame falls upon an oil filter where it is thoroughly cleaned and purified. The large base gives the oil an excellent opportunity to cool and settle.

In their own shops the manufacturers have been experimenting with this engine for some two years past, and in connection with their experiments relate a novel experience. An engine was adjusted and filled with oil; after four months no readjustments of any character had been made, and no oil added except to fill the sight feed cylinder lubricator. The engine has been operating from fourteen to sixteen hours per day driving a blower, and after the lapse of over four months needed no readjustment or fresh lubricant, and was running almost as noiselessly as at the first.

It will, therefore, readily be seen that this engine is particularly valuable for use where continuous operation is required or peculiarly heavy duty is imposed upon the engine, as in driving blowers, dynamos, pumps, and similar apparatus.

Further information can be obtained from the designers and builders, the American Blower Company, of Detroit.

The "Little Gaint" in Coal Mining.

IN rock work encountered in sinking shafts and driving drifts and slopes in American coal mines, the "Little Giant" rock drill is capable of doing the greatest amount of work with the greatest economy of maintenance. The construction of this drill fits it particularly for drilling in ail kinds of rock throughout the coal fields as well as in mines producing metal ores. To meet the exact requirements of coal miners, the Rand Drill Company of New York have so modified their standard rock drill that they are now offering, in the "Little Giant," a drill which is specially adapted to coal mining; and its effectiveness in this work is securing its rapid introduction in every principal coal-mining region in the country.

A LITTLE GIANT DRILL AT WORK IN A MINE NEAR BUTTE, MONTANA.

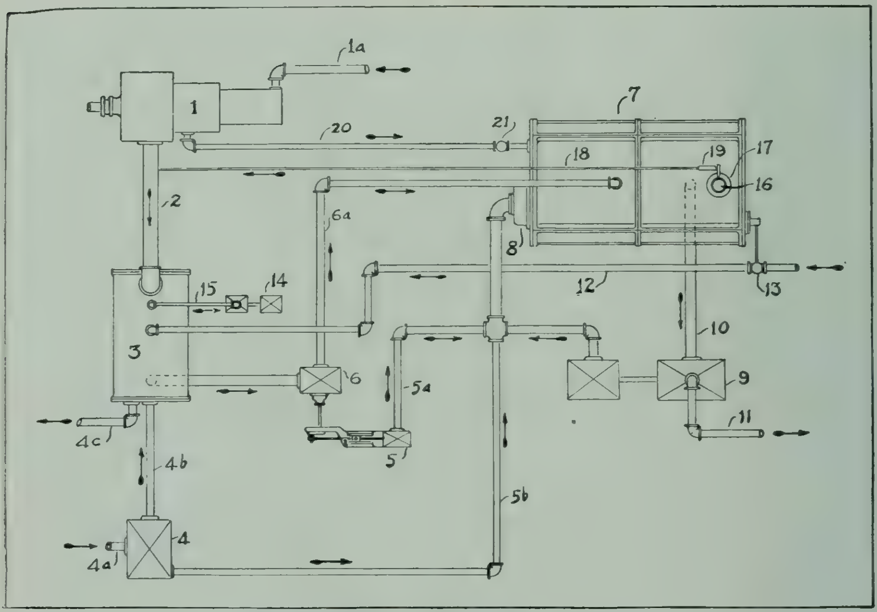
We present an illustration of the "Little Giant" at work in a mine in the West; and the chief points which distinguish the machine from all others employed for like purposes, are as follows: It muds well, i. e., the drill throws the mud out of the hole at each stroke, enabling the drill to cut fresh ground; the positive valve movement insures certain operation when steam or air is admitted, without dependence upon close fits or clean parts; it allows of a variation in design between the up and down stroke, thus economizing steam and increasing the working capacity of the machine; the clean and sharp cut-off is the principal cause of its steam or air economy; the whole mechanism is so simple and direct that there is never any difficulty in running at any desired speed; and there is no waste of power (due to leakage) after long and constant use.

The Rand Drill Company, 128 Broadway, New York City, will be pleased to supply descriptive matter, illustrations, and detailed information as to the profitable use of this drill in coal mining particularly, as well as its past performances in other drilling work.

New Feed-Water Heater.

AMONG the new problems and opportunities presented by the recent commercial development of the steam turbine is the application of the auxiliary equipment in plants operated by turbines. The Harrison Safety Boiler Works of Philadelphia have paid special attention to the adaptation of the Cochrane heaters to such plants, and they have developed some features in these installations which should prove of considerable interest to engineers. The accompanying illustration shows an approved method, designed by them and covered by letters patent, for heating and regulating the boiler feed water, and is particularly adapted to plants where the steam turbines are operated in connection with surface condensers, although this method is also applicable to plants where surface condensers are used in connection with reciprocating engines.

1 is the main steam turbine taking steam through the pipe 1a from the boiler; 2 is the exhaust pipe from the turbine to condenser; 3 is the surface condenser receiving the exhaust from 2; 4 is a pump taking cold water through suction pipe 4a and forcing it through pipe 4b into the condenser to condense the exhaust steam therein, 4c is the discharge for the circulating water from the condenser; 5 is an auxiliary engine driving a pump, 6, for drawing the condensation of the steam from the condenser and delivering it to the open heater through the pipe 6a; 5a is the exhaust pipe from this auxiliary engine joining the exhaust 5b from 4; 7 is a Cochrane feed-water heater receiving the exhaust from the auxiliaries through the oil separator 8; 9 is a pump taking the feed water from the heater through the pipe 10 and discharging it to the boilers through the pipe 11. The exhaust from this pump,



NEW HARRISON FEED-WATER HEATER.

joining the other auxiliary exhaust, enters the separator 8; 12 is the supplementary cold water feed supply emptying into the condenser, 3, to make up any difference between the quantity of the condensation of the steam and the amount of water required by the boilers. The supplementary water is controlled by the valve, 13, according to the level of the water in the heater, 7 (this valve is automatically closed or opened by the float and connecting mechanism); 14 is an air pump exhausting air from the condenser 3 through the pipe, 15 (in cases where this pump is steam driven the exhaust also enters the separator, 8); 16 is the exhaust from the heater to the atmosphere and is provided with a back pressure valve 17; 18 is an air pipe leading into the condenser and provided with the air valve, 19, for passing to the condenser the air which is liberated from the water by heating it in the heater. By this means the air in the heater is disposed of without permitting the escape of steam.

Should there be more exhaust from the auxiliaries than can be condensed in the heater, the pressure increases until it is high enough to open the back-pressure valve, 17, and allows the surplus to escape to the atmosphere. It often occurs, however, that the steam from the auxiliaries is insufficient to heat the feed water to the temperature of the steam itself. In order to cover such cases the pipe 20 is carried to the heater from such a point of expansion in the turbine as will insure the least loss of effectiveness with the greatest potentiality for the purpose of making up any possible deficiency in the auxiliary exhaust. In the pipe 20 is placed an automatic throttling valve, 21, so adjusted that the pressure of the steam when it enters the heater shall be below the pressure at which the back-pressure valve 17 is set. Thus the supply of supplemental steam from the turbine depends upon the pressure in the heater, and is regulated by the needs of the heater itself.

The operation of this novel arrangement has important advantages. In addition to all of the condensation of the main exhaust being utilized in the heater, the supplementary cold water is automatically regulated and supplied, and is partially heated in the condenser by the utilization of the latent heat in the main exhaust. All of the exhaust from the auxiliaries is utilized up to the point where they provide more exhaust than is required in the heater, and should the supply fall below the maximum quantity required it is automatically supplemented by steam in the manner already described. The boilers are furnished with water at a uniformly high temperature, there being no sudden fall in the temperature due to variations in the quantity of steam available for heating the water or in the quantity of the supplemental cold water required. The methods by which these desirable results are obtained are single, positive and entirely automatic.

It will be seen that in a plant in which this method of heating and regulating the boiler feed supply is used the auxiliaries are of the independent, steam-driven, noncondensing type. The manner in which the exhaust from these auxiliaries is utilized, however, makes them far more economical than the turbine or main engine run condensing, even though the latter may show an efficiency of 15 per cent. or better. If the auxiliaries were run condensing they could not exceed and probably would not equal this efficiency of 15 per cent., but when operated in the manner described above, their efficiency is practically 100 per cent. for all of the heat in the steam which is not converted into work or accounted for by losses from radiation, etc. (and these quantities would be identical whether the auxiliaries were run condensing or nondensing) is utilized in heating the feed water and turned back into the boilers. This efficiency of 100 per cent. compares with the absolute loss of 85 per cent. which must occur if the auxiliaries are run condensing and the heat in the exhaust dissipated and wasted in the condensing water.

The Johnson Patent Arch Plate.

THE Johnson patent arch plate for facilitating the work of repairing and rebuilding furnace door arches, is shown in the accompanying illustration. The arch plate when in use is attached to the ram of the charging machine. The furnace door is raised out of the way and the charging machine inserts the plate in the charging opening of the furnace, holding it there in proper position until the repairs are completed, when it is withdrawn and detached from the ram of the charging machine.

The arch plate serves, first, as a shield against the heat from the interior of the furnace, thus enabling the work of repairing the arch to be carried on without shutting down the furnace. In repairing arches without this device, it is necessary to build up a temporary protecting wall or bulkhead of brick; and on account of the heat, this must be done with long handled tools, making the process both awkward and tedious, as well as expensive, as it necessarily delays the operation of the furnace. All this is obviated by the use of the Johnson arch plate, and the repairing greatly facilitated.

This arch plate also serves as a form on which the arch can be quickly relaid, supporting the arch during construction. The flange acts as a stop for the bricks in laying the arch.

The Johnson arch plate is made of cast steel, and hence is a permanent appliance which can be utilized on short notice, so that work which would ordinarily require hours in the old way, can, by using it, be done in a small fraction of the time, while the charge of steel is being melted down, and without any delay to the furnace.

The Wellman-Seaver-Morgan Company, of Cleveland, who are the sole manufacturers of the Johnson patent arch plate, publish bulletins giving full details of its performance in actual use, and will be glad to send the same to all inquirers, free of charge.

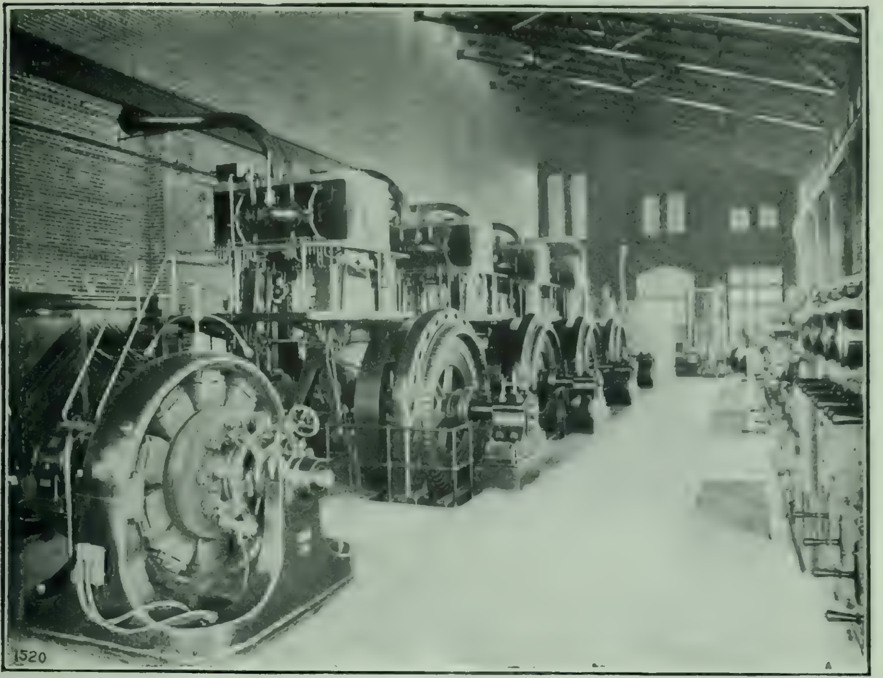
JOHNSON ARCH PLATE.

Compressed Air Plant at St. Louis.

THE compressed air power plant at the Union Terminal Station at St. Louis is of note because of the diversity and extent of the applications of air power. It is a good example of the central compressed air-power plant—the fruit of the present tendency towards centralization of power.

The compressing plant proper is in the main power house of the terminal and consists of two duplex steam-driven two-stage air compressors built by the Ingersoll-Sergeant Drill Company, New York, of the type known as Class "GC." The power of each compressor is about 350 horse power, and at the rated speed of 100 revolutions per minute the free air capacity of each unit is 2,180 cubic feet per minute. The steam pressure applied is 150 pounds and air is delivered to the center of distribution at a pressure of 85 pounds. The steam cylinders of the compressors are 18 inches in diameter; air cylinders 32¼ and 20¼ inches in diameter; the stroke is 24 inches. The machines run non-condensing and a distinctive feature is the piston inlet valve which is applied on both high- and low-pressure air cylinders.

Cool air is led to the compressors from outside the engine room through a supply conduit and the air discharge is delivered to twin receivers in a cooling house or tower outside the main building. The air from these primary receivers passes through a system of secondary receivers, headers and cooling tubes, which reduces the tem-



ENGINE ROOM IN THE POWER PLANT OF THE ST. LOUIS RAILWAY TERMINAL STATION.

perature to that of the outside air and condenses all moisture, which collects in the receivers and is removed through drain cocks. The perfection of the cooling and drying process will be appreciated when it it stated that only once or twice in the most extreme weather has it been necessary to inject alcohol into the air pipes to prevent freezing of the delicate valve mechanisms of the switch and signal system.

The applications of the air power are those common to all railway, shop and yard service. From the cooling house, which is the center of distribution, five main pipe lines radiate. The distances to which power is transmitted range from 1,800 to 5,000 feet; five distinct yards being served from this central plant.

Among the applications of the air may be mentioned the following: pneumatic tools, hoists and jacks in the various shops and yards; charging the brake reservoirs of stationary trains; cleaning cars and car fittings; pneumatic dispatch tube systems; the operation of air engines for a variety of purposes, among them direct connected generating sets supplying current for the electric signal system; Shone ejectors or displacement pumps handling the seepage water in the terminal subway; direct-acting bilge pumps in the accumulator pit of the hydraulic elevator system; and a pneumatic switch and signal system controlling the train movements of the entire terminal organization.

The electro-pneumatic switch and signal system was installed by the Union Switch & Signal Company and its extent will be realized when it it said that during the Exposition traffic the number of trains handled each day in the terminal averaged between 500 and 550, aggregating 2,000 to 2,500 cars. This means the passenger traffic only, and does not include the freight service which passes over the terminal trackage. At the main terminal station alone the number of signals is 284, the number of switches 157, and the number of bridges 20. In addition there are in the Fourteenth Street, Twenty-third Street and Grand Avenue yards probably an equal number of switch and signal appliances.

Northern Motors in Paper-Mill Work.

NOTABLE among the numerous electrically driven paper mills now operating in the United States is the plant of the Consolidated Water Power and Paper Company, of Grand Rapids, Wis. Chief interest centers, of course, in the big variable-speed motors operating the paper machines, but there are numerous other individually driven machines in the plant.

Electric motor drive in the plant of the Consolidated Water Power and Paper Company is a business proposition, pure and simple. With the abundance of power at hand the company could afford to stand the losses of power transmission due to all-belt transmission. Convenience was an important factor in the planning of the mill, the designer holding forth for the constant economies obtained by the convenient arrangement of machines and departments to secure reduction in labor costs. The mill is laid out on modern lines, the raw material entering the plant at its upper end, and emerging at the shipping platform at the lower end.

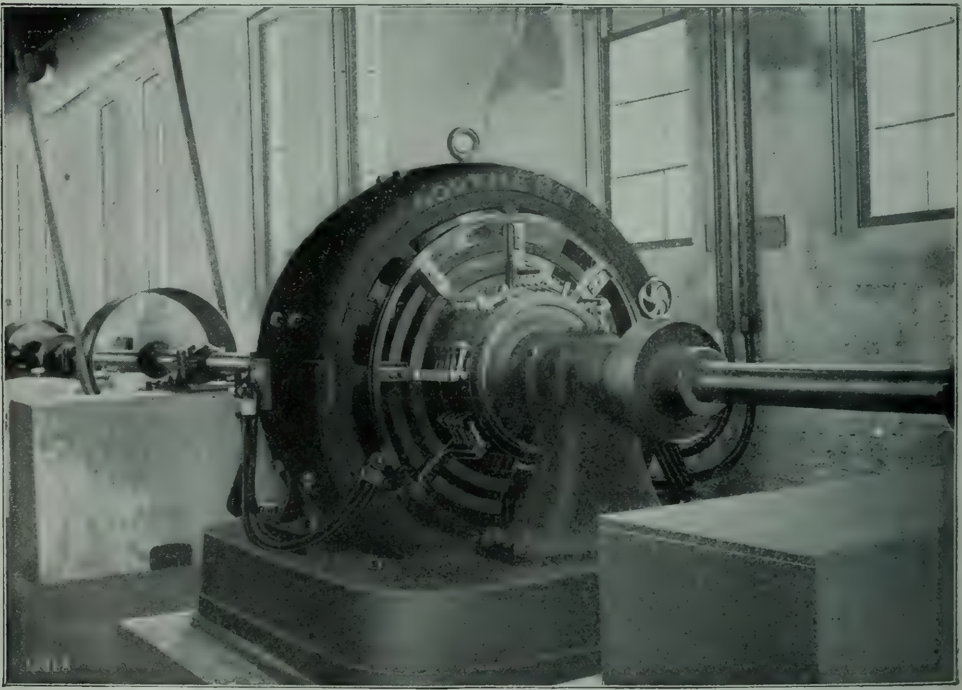
All conveyors, barking and "wet" machines, Fourdriniers, fans, and the machine shop are direct connected to motors. The grinders, heaters and Jordans, however, are arranged on the turbine shafts.

This plant is a decided triumph for direct-current motor drive in paper-mill work. The dynamos and motors installed are potent factors in an increase of output, owing largely to the convenience of operation secured.

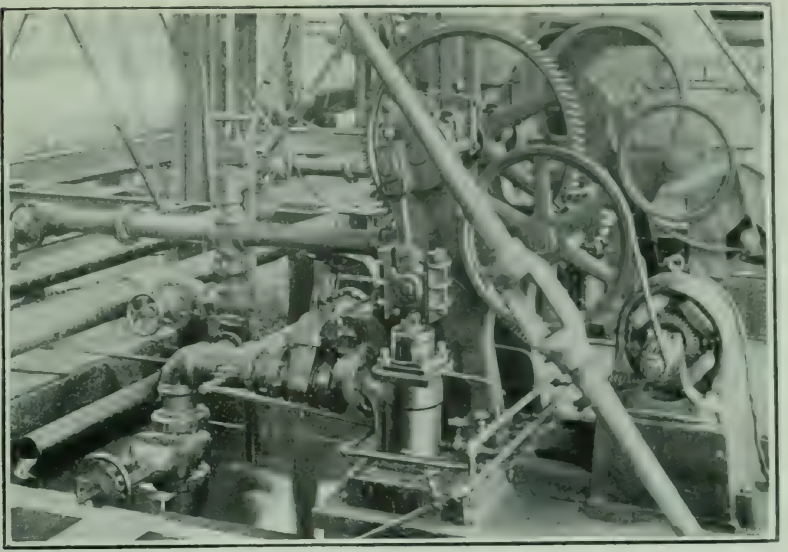
Further information regarding this very interesting installation will be furnished by the Northern Electrical Manufacturing Co., Madison, Wis.

Pumping Tar and Other Heavy Liquids.

IN many industries it is necessary to force heavy, viscous liquids through pipes. This involves difficulties not encountered in ordinary pumping, and requires machinery of special design and construction. When the liquid is heavy but not adhesive, as in the case of heavy oils, the action can be made fairly satisfactory and efficient by



NORTHERN MOTOR ON LINE SHAFT IN A PAPER MILL.



PUMP FOR TAR OR OTHER HEAVY LIQUIDS.

enlarging the valve openings, making the parts of the pump heavier, and so arranging the passages of the pump that there is little liability of choking or clogging. When, however, the liquid is a fluid at high temperatures, but becomes a gelatinous adhesive paste or a rubbery solid, clinging to all surfaces and choking openings through which it should pass, as the temperature is lowered, a design differing materially from the ordinary pump must be used.

Gas tar has a number of characteristics rendering it exceptionally difficult to pump. Its condition varies from a solid to a penetrating fluid within a small range of temperature. Two pumps which have proved very efficient in lifting and forcing gas tar were installed a short time ago at the plant of the Maryland Steel Co., of Sparrows Point, Md. One of the illustrations shows the pumps in position, the one in the foreground being idle and the one in the background working under its normal load. They were built by the Deane Steam Pump Co., of Holyoke, Mass., and are of the standard triplex type of that company, fitted with ball valves peculiarly adapted to this service. The exclusive use of gate valves in the piping system is also interesting. A very flexible power connection is obtained by the use of the Renold silent chain and a four-pole, alternating-current, 3-horsepower motor. The gearing consists of an 18-tooth pinion running at 950 revolutions per minute and a 120-tooth wheel running at 142 revolutions per minute. The chain used has links ¾ inches wide and 1½ inches long. It transmits the 3 horse power generated at 950 feet per minute, giving an excellent efficiency when the service is considered.

A liquid peculiarly difficult to handle is oil-refinery tar, which is usually very hot when it reaches the pump. There is a large percentage of suspended particles of various sizes present in this tar and also a certain amount of unrefined paraffin. The tar is sometimes heated to a temperature of 300 degrees; but quickly cools off if not properly handled, and coats the retaining valves and walls with layers of an adhesive substance closely resembling finely divided particles of coke. To overcome the difficulties the ordinary pump arrangement and design is materially changed.

Another illustration shows a specially designed pump installed by the Deane Company for handling oil-refinery tar at the works of the Atlantic Refining Co., in Philadelphia. By a new arrangement, exceptionally large valve areas are made available, the valves being designed to permit the passage of the substance pumped with the least possible frictional resistance. The suction, discharge and pulsation chambers can be taken apart without unnecessary expenditure of time or labor, and each is in a position where it can be readily reached for cleaning. The pump is of the triplex type, as shown in the illustration, and is fitted with ball valves, which thorough test has proved best adapted for the passage of heavy substances. There are a number of large hand holes for cleaning the valves. The illustration shows the rigid cross-head guide system and the strong design of the chambers, rods, pistons and bearings.

Machinery which will pump these adhesive oils and other similar substances can be used in many industries, and will save the laborious processes by which this class of work is generally accomplished.

Further particulars regarding this pumping machinery will be furnished on request, by the Deane Steam Pump Co., of Holyoke, Mass.

The Measurement of the Gases.

TWO pyrometers worthy of attention have recently been put on the market. They are the Queen mercurial pyrometer and the Queen electrical pyrometer, constructed by Queen & Co., Philadelphia, for measuring the temperatures of flue gases, although they are made in such convenient forms that they will measure accurately any temperatures that come within their ranges.

The makers claim that by a special process in the manufacture of the mercurial pyrometer they have eliminated any possible change of the scale from constant use at high temperatures. This form of pyrometer will measure all flue gases up to 1,000° Fahrenheit, and owing to its sensitiveness it is much more desirable than the old form of metallic pyrometer.

The proper regulation of the temperature of flue gases by means of the pyrometer will cause a saving in the coal bill of at least ten per cent. Another application to which the pyrometer is put is its use for measuring and regulating the temperatures in core ovens. Few realize how much better results are obtained when cores are baked at a proper and uniform temperature.

For temperatures over 1,000° Fahrenheit an electrical pyrometer is used. The Queen pyrometer will measure up to the fusing point of platinum, 3,200° Fahrenheit. The feature of this pyrometer is that it will record the temperatures at a distance,, so that the chief engineer may sit at his desk and read the temperatures of the stack.

The Queen electrical pyrometer involves the same principles as the Le Chatelier pyrometer: that is, the measurement, by a very sensitive d'Arsonval galvanometer, of the current of electricity generated when the junction of a thermo-electric couple is heated. The galvanometer, or pyrometer proper, is in reality a millivoltmeter, absolutely dead beat, arranged in a portable form for carrying from place to place.

The thermo-electric couple consists of one platinum wire and one platinum rhodium wire fused together and protected by suitable porcelain and iron tubes. It is connected to the pyrometer by two ordinary insulated wires, no batteries being used. The pyrometer is of such high internal resistance, that any change in the length or temperature of the connection has no appreciable effect on the reading.

A feature of the pyrometer is its portability; it can safely be carried or shipped with only ordinary precaution. Its accuracy is guaranteed by the manufacturers to be within one per cent. and not to change with constant use.

NEWS SUPPLEMENT

The Engineering Magazine—March, 1905

Personal.

—William Sellers, founder of William Sellers & Co., Inc., Philadelphia, died last month at the University Hospital, Phila.

—Edward H. Mullin, manager of the Publicity Department of the General Electric Co., died suddenly at his home in Milburn, N. J.

—E. L. Byron, who for the past twenty years has been connected with the Vulcan Iron Works Co., has been advanced to the position of general manager. Alexander Backus will not retire from that place, but Mr. Byron will take much of the responsibility that has hitherto rested on the shoulders of Mr. Backus.

—Warwick H. Payne, who has for a number of years been connected with the Eureka Fire Hose Co., New York, as manager of their southern department, has been placed in exclusive charge of the States of North and South Carolina and Virginia, with headquarters at 704 Century Bldg., Atlanta, Ga.

Industrial Notes.

—A. L. Ide & Sons, Springfield, Ill., has opened a New York office at 11 Broadway. J. G. Robertson will be the manager.

—Hess-Bright Mfg. Co., Philadelphia, the manufacturers of ball bearings, has recently removed its offices to 245-47 No. Broad St.

—R. D. Nuttall Co., Pittsburg, has appointed the Chas. W. Wood Electric Co., 246 Summer St., Boston, their agent for the sale of Nuttall material in the New England States.

—Falkenau-Sinclair Machine Co., Philadelphia, who are retiring from business, offer for sale a fine modern machine manufacturing plant, with business ready for operation.

—Morse, Williams & Co., Philadelphia, with branch offices in Boston, New York, Baltimore, and Atlanta, have opened an office at 1018 Penn Ave., Pittsburg, for the sale and erection of all classes of freight and passenger elevators.

—Hanna Engineering Works, Chicago, manufacturers of pneumatic tools, has made arrangements with the Thos. W. Pangborn Co., 42 Dey St., New York, and Edward J. Etting, Harrison Bldg., Philadelphia, to act as their exclusive agents for the territories in which they are located.

—The A. S. Cameron Steam Pump Works, New York, report the sale of three more of their horizontal piston pumps to the O'Rourke Construction and Engineering Co., New York, contractors for the improvement in the Pennsylvania R. R. tunnel.

—The University of Tennessee, Knoxville, Tenn., has purchased from the A. S. Cameron Steam Pump Works, New York, through McClung & Co., their agents in Knoxville, a Cameron regular boiler feed pump as a part of the laboratory equipment in the mechanical engineering department for the use of students in laboratory tests.

—The Ingersoll-Sergeant Drill Co., New York, has sold to the American Car & Foundry Co., its entire pneumatic equipment including air compressors and Haeseler hammers and drills for use in equipping its new English shops where the steel cars for the London Underground Railway are to be built.

—Broderick & Bascom Rope Co., St. Louis, received five highest awards, all told, on their exhibit of wire rope and haulage systems at St. Louis. Two of these were Grand Prizes on wire rope, one being in the Mines and Metallurgy Building, and the other, in the Manufacturers' Building; and a third was a Grand Prize for underground wire rope haulage.

—The annual convention of officers and branch managers of Crocker-Wheeler Co. took place at the main office and works, Ampere, N. J., January 26, 27 and 28. Managers and representatives were in attendance from all parts of the country. On the evening of the 27th a banquet was held at the Café Martin in New York, at which the president of the company, Dr. Schuyler Skaats Wheeler, presided.

—The Allis-Chalmers Co., Chicago, has consolidated their officers with those of the Bullock Electric Mfg. Co., in the following cities: St. Louis, Chemical Bldg., H. P. Hill, manager; Cleveland, New England Bldg., Franklin Wharton, manager; Pittsburg, Frick Bldg., H. Wiederman, manager; Kansas City, Dwight Bldg., George W. Mattison, manager; and Buffalo, Ellicott Square Bldg., George W. Pulver, manager.

—Marine Iron Works, Chicago, are building a new steamer for quick passenger service on northern Lake Michigan. She will have a steel hull, 142 feet long by 28 feet beam, and will draw, with ordinary load, 11 feet. The engine cylinder diameters will be 14 and 22 and 36 inches by 24 inch stroke, fitted with steam reverse. They have also been awarded the contract for building the fore and aft compound condensing machinery for the new Government survey boat for use on the coast of the Gulf of Mexico.

—Loew Supply & Mfg. Co., Cleveland, has recently engaged in the manufacture of steam specialties and have received the following orders: Doan-Jones Lumber Co., Elmira, N. Y., 150-horse power combination feed water heater grease and oil separator; Kitson Machine Co., Lowell, Mass., 150-horse power combination feed water grease and oil separator; Lion Brewery, New York, one 6-inch oil separator, 1,000-horse power combination feed water grease and oil separator; Trenton Hygie Ice Co., Trenton, N. J., 12-inch Loew grease and oil Separator; Citizens Water Supply Co., Newton, Elmhurst, N. Y., 250-horse power combination feed water heater grease and oil separator.

—The new type of magnet for handling pig iron, small billets, scrap iron or steel, small steel or iron castings, bolts, rivets, etc., in bulk, recently put on the market by the Electric Controller & Supply Co., Cleveland, is the result of long experience and persistent experimenting to get the most efficient design. It is adapted to carry on the hook of a crane and can be controlled by the crane man, who can thus perform the entire operation of loading or unloading a car or loading melting stock into charging boxes with no ground men or helpers. This type of magnet has so obviously supplied the demand for a means of materially reducing the cost of handling such raw materials that the company is experiencing a heavy call for it.

—The Pelton Water Wheel Co., San Francisco, report several recent sales as follows: One 700-horse power Pelton wheel for the hydraulic plant of the Grande Ronde Electric Co., Oregon; one 450-horse power Pelton wheel for the Nanaimo Electric Light and Heating Co., British Columbia; one 600-horse power Pelton wheel to be direct coupled to a 400-horse power Allis engine for the Silver Lake Mines, Colorado; one 450-horse power Pelton wheel unit is also under course of construction for the Territorial government of Hawaii and a 900-horse power unit for the La Grande Water Storage Co., Oregon. Pelton combination needle and deflecting nozzles are used, the deflecting portions being handled by Sturgess and Lombard governors.

—The Westinghouse Electric & Mfg. Co., Pittsburg, has just closed a contract for the electrical equipment of the cotton mill of the Dwight Mfg. Co., Chicopee, Mass. The contract provides for the following apparatus: one 440-volt, A. C. generator, 900-kilowatt rated capacity to supply three-phase current at a frequency of 60 cycles. This generator is to be direct connected to a C. & G. Cooper 26 and 52-inch by 48-inch stroke cross compounding condensing; one 25-kilowatt excited direct connected to Westinghouse engine, and one 22½-kilowatt motor driven exciter. There will also be provided a four panel switchboard to control generator, exciters and six feeds. The electric power plant is to be placed in a new building to be built as an addition to one of the present engine houses; in this way putting the two engines under the supervision of one engineer. To utilize the current produced by this plant the following Westinghouse type C motors wound for 60 cycles, three-phase, will be located in the various parts of the mill: Two 200-horse-power 580 R. P. M.; six 100-horse power, 580 R. P. M.; three 75-horse power, 690 R. P. M.; three 50-horse power, 850 R. P. M.; and two 40-horse power, 850 R. P. M.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Chucks.

Catalogue, containing illustrations, descriptions and prices of lathe and drill chucks. 6 by 9 in.; pp. 32. Westcott Chuck Co., Oneida, N. Y.

Converters.

Bulletin No. 1031, treats of rotary converters. Contains illustrations of several converters installed at the So. Chicago Railway Co.'s plant. 6 by 9 in.; pp. 12. Bullock Elec. Mfg. Co., Cincinnati.

Conveying Machinery.

Catalogue No. 28, illustrating and describing the full line of elevating, conveying and power-transmission machinery manufactured by this company, with price lists, tables of dimensions, a comprehensive index, and other valuable information regarding this class of machinery. Contains several views of their plant. Is well printed and is bound with a cloth cover. 6½ by 9¼ in.; pp. 736. H. W. Caldwell & Son Co., Chicago.

Crushing Rolls.

Leaflet, containing illustrations and descriptions of crushing rolls for roughing and finishing. 9 by 8 in.; pp. 6. Sturtevant Mill Co., Boston.

Digging Machinery.

Handsome catalogue covering the full line of digging machinery manufactured by the Hayward Co., with photographic views showing the well-known orange-peel and clam-shell buckets, railroad excavators, steel traveling derricks, coal handling machinery, etc., with their application. This includes their use in dredging and excavating, grading and ditch digging, for railways, dredging and deepening canals and harbors, sinking cylinders and caissons for bridge piers, well sinking and ore bed digging, rock, broken stone and phosphate dredging and placer mining. It is finely printed and illustrated. It also contains prices and full particulars. 9¾ by 11¾ in.; pp. 104. The Hayward Co., New York.

Educational.

Catalogue specifying the courses offered for the professional degrees of mechanical, civil, chemical and electrical engineer by the various departments. It also gives full information in regard to entrance requirements, courses of study, equipment, etc. 6 by 9 in.; pp. 214. Worcester Polytechnic Institute, Worcester, Mass.

Electric Hoists.

Bulletin No. 35, devoted to "Electric Hoists." It contains illustrations, descriptions, tables of dimensions and other valuable data concerning electric hoists. 11 by 8 in., pp. 10. General Pneumatic Tool Co., Montour Falls, N. Y.

Electric Meters.

Bulletin No. 3, describes a new and improved form of integrating meter for direct current. Contains illustrations showing interior views of the meter. 6 by 9 in.; pp. 8. Sangamo Electric Co., Springfield, Ill.

Feed Water Heaters.

A reprint of a paper by Reginald Pelham Bolton entitled "Circulation of Steam for Heating Purposes at or below the Pressure of the Atmosphere." 6 by 9 in.; pp. 20. Warren Webster & Co., Camden, N. J.

Friction Clutches.

Catalogue describing and illustrating patented friction clutches and cut-off couplings and friction-clutch pulleys, with their parts. 6 by 9 in.; pp. 24. Also, catalogue devoted to pulp-saving apparatus for paper mills. 6 by 9 in.; pp. 16. The Pusey & Jones Company, Wilmington, Del.

Gears.

Illustrated pamphlet, containing descriptions of the different types of gears and pinions. Contains tables giving dimensions, prices, etc. 7¾ by 9¾ in.; pp. 48. R. D. Nuttall Co., Pittsburg.

Grinders.

Pamphlet, describing and illustrating electrically driven grinders and breast drills. 3½ by 6 in.; pp. 16. Jas. Clark, Jr., & Co., Louisville, Ky.

Imperial Air Compressors.

A 32-page illustrated pamphlet specially designed to indicate the wide variety of uses for compressed air in general manufacturing—the purpose being to show that the machinery which has proved so effective in mining, quarrying, pumping, etc., as now modified and adapted to special uses, makes air power equally effective in the machine-shop, the factory, the foundry, and especially the shipyard. The Rand Drill Co., 128 Broadway, New York.

Industrial Railways.

Pamphlet No. 051, illustrates and describes shop, self-dumping, tip, charging and foundry ladle cars. Also contains views of recent installations in machine shops, foundries, boiler rooms, etc. 3¼ by 6 in.; pp. 40. Also, pamphlet No. 052, devoted to coal conveyors, coal screens and valves, coal crackers, overhead trolleys, cable and automatic railways, hoisting engines, etc. Illustrated. 3¼ by 6 in.; pp. 20. C. W. Hunt Co., West New Brighton, N. Y.

Injectors.

Catalogue, pocket size, containing illustrations and descriptions of the Metropolitan automatic injectors, with tables of dimensions. Ejectors, strainers, and check valves are also treated. 4 by 6 in.; pp. 48. Hayden & Derby Mfg. Co., New York.

Inspirators.

Catalogue, pocket size, giving the history ot the Hancock inspirator since 1868. Also contains much vaulable information in regard to selecting the proper size of inspirator, together with tables giving dimensions, prices, etc. Fully illustrated. 4 by 6 in.; pp. 54. Hancock Inspirator Co., New York.

Lamps.

Bulletins 7030, 7035, and 7040, illustrating and describing the different types of arc lamps. 10½ by 7¾ in. Western Electric Co., Chicago.

Motors.

The Robbins & Myers Co., Springfield, Ohio, has recently issued a very comprehensive price list of their "Standard" motors and generators. It is side-pocket size and contains lists of their various types of motors as regularly furnished for various applications, from 1/16 to 15 horsepower, and dynamos from ½ to 10 kilowatts.

Paint.

"Hints on Painting Structural Steel" is the title of a booklet by Houston Lowe, vice-president of the Lowe Brothers Co., Dayton. It considers the paint, the material to be covered—steel, iron, etc.—the liquids and solids eligible for metal coverings, and the proper tests for paint users. The book is full of suggestive sentences and is the result of years of study. experiment and practice. It is unusually valuable as a practical handbook.

Power Hoists.

Descriptive catalogue showing several recent installations. Contains numerous testimonials. 6 by 9 in.; pp. 24. C. S. Harris Co., Rome, N. Y.

Radial Drills.

Catalogue, illustrating and describing the different drills manufactured and giving dimensions of same. Center grinders are also illustrated. 6 by 9 in.; pp. 12. Mueller Machine Tool Co., Cincinnati.

Rock Drills.

Pamphlet entitled "Driving the New York Subway," which gives a concise account of this great undertaking and tells of the important part played by Ingersoll-Sergeant rock drills, air compressors and other machinery in its construction, with half-tone illustrations. 7 by 5 in.; pp. 32. The Ingersoll-Sergeant Drill Co., 26 Cortlandt St., New York.

Rock and Ore Breakers.

Catalogue No. 117, illustrating and describing styles "D" and "F" of the Gates rock and ore breakers. Contains a list of the principle products manufactured by this company, together with a list of its offices and works. Allis-Chalmers Co., Milwaukee.

Separators.

Catalogue, giving a well illustrated description of Sweet's separators. 6 by 9 in.; pp. 38. Also pamphlet giving reports of tests and list of users. 6 by 9 in.; pp. 40. Direct Separator Co., Syracuse, N. Y.

Catalogue, containing illustrations of horizontal separators, together with tables giving sizes and prices. 5 by 6½ in.; pp. 16. Greenaway Co., Detroit.

Small Tools.

General catalogue 1905, covering the line of machinery and tools manufactured. Contains numerous illustrations and tables giving dimensions, prices and other valuable data. 3½ by 6 in.; pp. 494. Brown & Sharpe Mfg. Co., Providence.

Steam Turbines.

Catalogue illustrating and describing the Westinghouse-Parsons steam turbine. Contains views of different parts of the turbine, together with some recent installations. Also contains three tables giving the results of tests. It is handsomely printed. 6 by 9 in.; pp. 38. The Westinghouse Machine Co., East Pittsburg.

Steel Factory Equipment.

Catalogue illustrating and describing steel racks, tool boxes, trays, barrels, lathe pans, benches, desks, trucks, lockers, gear cases, etc. 6 by 9 in.; pp. 48. Lyon Metallic Packing Co., Chicago.

Steel Process.

Pamphlet, containing illustrations and descriptions of the Tropenas converter steel process for making steel castings direct, and of some of its characteristic products. In this process, pig iron and selected scrap are melted in a cupola and run into a small converter, where a low-pressure blast is directed above the surface of the metal, and ferro-manganese and other desirable ingredients are added. The resulting steel is intensely hot and makes excellent castings. 9 by 6 in.; pp. 29. Powell & Colué, 11 Broadway, New York.

Thermometers.

Catalogue Part 2, containing detailed description of thermometers and other meteorological instruments specially adapted for use in heating and ventilating, also in general meteorological observations. Fully illustrated. 7 by 10 in. pp 32. Hohmann & Maurer Mfg. Co., Rochester, N. Y.

Turbines.

Bulletin No. 1, containing illustrations and descriptions of very large water turbines and centrifugal pumps, with views of great installations at Niagara, Shawinigan Falls, New Orleans and elsewhere. 10½ by 8½ in.; pp. 51. I. P. Morris Company, Port Richmond Iron Works, Philadelphia.

Valves.

Catalogue A illustrating and describing the valves manufactured by this company. Contains lists of dimensions, prices, etc. Elbows and valve repairs are also given a place. 3½ by 6½ in.; pp. 32. C. W. Thomas, Detroit.

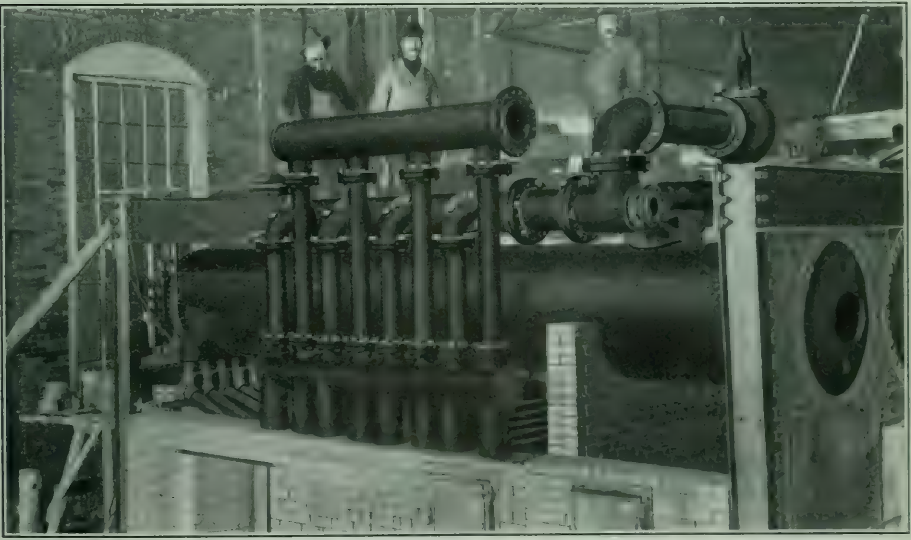
IMPROVED MACHINERY

New Processes and Appliances

The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Protection of Steam Superheaters.

A SOURCE of expense in the operation of superheaters, when placed in the direct path of the products of combustion, is the burning of the superheater tubes. Hitherto the methods employed to overcome this have been the protection of the tubes by flooding with water, or by diverting the hot gases by means of dampers. The practice of flooding with water is questionable on account of the impurities in the water, more generally existing than not, which will scale up the tubes. Superheater tubes cannot be cleaned as is the case with boiler tubes, and it is therefore only a question of time when the coating of scale will be thick enough to cause overheating and consequent damage. Another objection to the use of water is the skill required to be exercised in flooding and draining at the right time to avoid water hammer. As regards the use of dampers, they are exposed to great heat and will become warped and inoperative. A third method has lately been devised—overcoming these objections and raising no others—by means of which the superheater tubes attached to any one boiler are supplied with saturated steam from the other boilers for the purpose of protecting the tubes when raising steam, or should a part of a battery be suddenly shut down for any reason. This is accomplished by running an auxiliary steam main connecting with the steam space of each boiler and the inlet header of each superheater. By this means a constant circulation of saturated steam flows through every superheater, is superheated, and passes into the superheated steam main. When fires are drawn



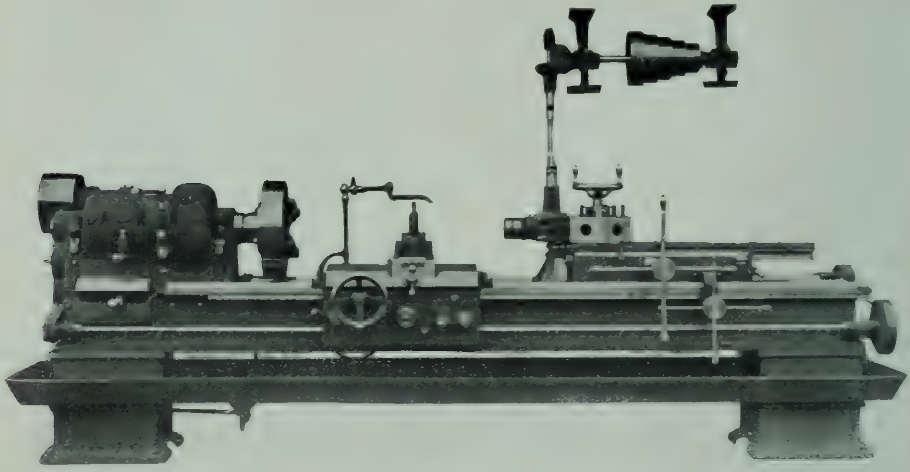
POTTER PROTECTION FOR SUPERHEATER TUBES.

from any boiler the circulation of steam through the superheater attached thereto is stopped by closing a valve on the branch from the auxiliary main to the inlet header of that superheater. By this means the superheater tubes will remain clean, they cannot scale up any more than a line of steam pipe, and the operation is extremely simple, entailing as it does the opening of one valve in the auxiliary pipe to the boiler being brought into service as soon as the superheater tubes are warmed up sufficiently to prevent condensation. This valve should remain open until the fires are again drawn from that boiler.

This system, which can be applied to any make of superheater that is directly attached to a boiler, entails very little additional expense, as the auxiliary main can be used also for pumps, etc., which are not usually designed for superheated steam. Further information will be gladly furnished to anyone interested by The Potter Separator Co., 39 Cortlandt St., New York, who are manufacturers of steam superheaters and other steam specialties.

A Special Boring Lathe.

THE accompanying illustration presents an interesting machine brought through by The American Tool Works Co., Cincinnati,—a 22-inch "American" lathe with patent all geared head, pan, oil pump, turret, and special boring device. The entire screw cutting mechanism has been omitted on this machine, inasmuch as the lathe is primarily intended for roughing and boring, and the feeding mechanism, while of the same principle as that regularly incorporated on the "American" lathes, is of a special nature. There are seven carriage feeds, ranging from .2 to .015, being scientifically graded for the greatest efficiency in that character of roughing and boring planned for this lathe by the customer. The geared head is of extremely simple powerful and efficient construction. Only six gears are required to obtain four speeds through levers shown on the front. This simplicity of construction enables the gears to be made of very wide face, and large diameters, thus giving the entire mechanism sufficient strength to transmit the maximum power delivered to the machine by a six-inch double belt. The four speeds obtainable through the head, in connection with a triple friction countershaft, supply twelve distinct speeds to the spindle, ranging from 5 to 322 revolutions per minute.



A SPECIAL BORING LATHE.

The carriage is fitted with plain block rest, which is provided with an interesting calipering attachment. This consists of a set of four adjusting screws, attached to the plain block rest after the manner of eyebolts, each one falling, when desired, over into corresponding slots in the yoke piece over the front carriage dovetail. By adjusting knurled locknuts on any of the four screws and dropping same into the slot, the travel of the cutting tool toward the center, and hence the diameter to be turned, is limited at pleasure. This attachment is very valuable in duplicate work, as adjustments can be made for duplicate turning of pieces with four shoulders.

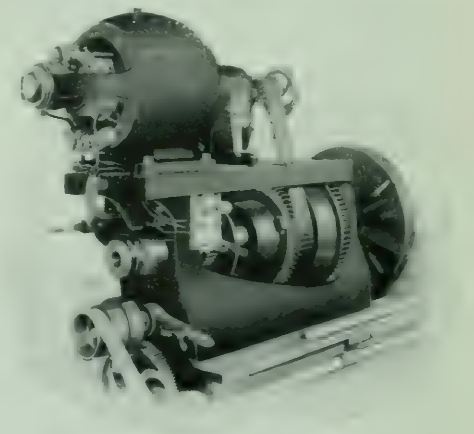
The hexagon automatic turret is of liberal size, with rapid and easy adjustments. It is provided with power feed, driven by sprocket chain from the feed rod, thus giving fourteen feeds to the turret, ranging from .16 to .007. The worm is dropped out of mesh with the wheel by an improved tripping device, adjustable at will from the front of the machine.

The turret slide has extra long bearing on the bed; the top slide has 24-inch movement, controlled by pilot wheel, and is supported on the front end by an improved supporting shoe, which slides on the ways, and is firmly bolted to the end of the turret slide directly under the cutting tool. It insures accurate alignment in boring, and has gibbed bearing both at the top and bottom of ways, thus preventing all spring in any direction.

The drilling attachment is affixed to one of the faces of the turret, and is extremely valuable in boring operations. It consists of a symmetrical housing carrying miter gears which actuate a spindle with ball-bearing thrust, which carries the boring bar. The spindle is made to revolve from a separate overhead countershaft, as shown in the illustration, by means of universal joints connected by a telescopic rod, which thus compensates for any movement of the turret slide. The boring spindle revolves in the opposite direction to the main spindle on the head, an obvious advantage. The boring spindle has five rates of speed through the cone pulley on the countershaft giving proper gradation to obtain the best results in the boring for which the lathe is intended. Whenever it is desired to use another face of the turret, it may be revolved without disturbing the drilling attachment, due to the telescopic rod. The boring tool is provided with oil supply, the same being drawn by an auxiliary pump up through the turret stem and boring bar. The carriage has a similar oil supply to the turning tool. The pan beneath the bed catches all waste oil, which is returned to the machine repeatedly. The lathe is very heavy and substantial throughout, to adapt it to the unusually heavy strains which a lathe of this character must undergo. Further information will be cheerfully furnished by the makers.

Changing to Motor Drive.

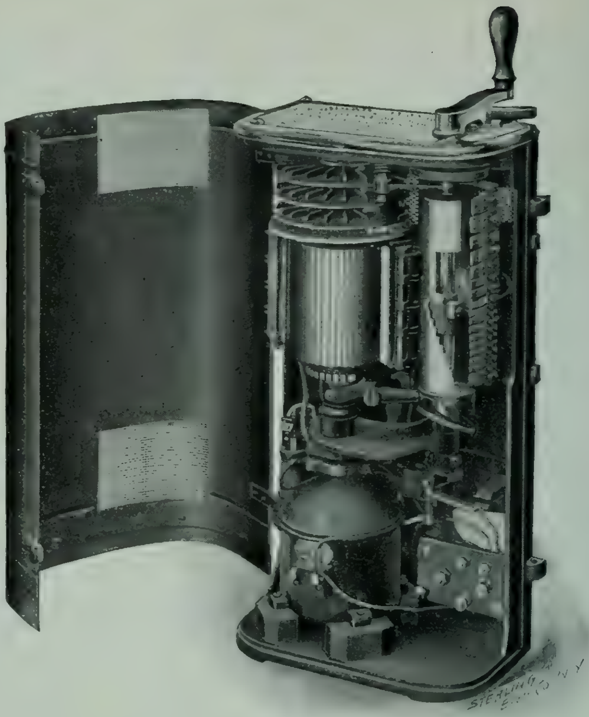
To enable owners of belted machine tools to apply electric motor drive to their old equipment the Northern Electrical Manufacturing Company, Madison, Wis., has developed a multi-speed motor. The object is to provide a combination of electrical and mechanical speed variation to secure a compact, self-contained unit which can be applied to the machine with but little change and at slight expense.



A LATHE CHANGED TO MOTOR DRIVE.

This motor combines a Northern single-voltage variable-speed motor of appropriate variation with a change gear box which supplements the motor variations. The application of the motor is very simple, and our illustration shows a representative drive accomplished by the use of this mechanism. The lathe headstock shown is that of an old Blaisdell engine lathe which was about to be discarded because it could not compete in productiveness with modern motor-driven machine tools. To accomplish the change the only alteration made in the machine was to remove the spindle-bearing caps. A simple saddle was designed to span the cone, to provide a support for the motor. The saddle replaces the bearing caps. The illustration clearly shows the method of drive. The cone was retained, and in order to apply a chain transmission a split gear was applied to the third pulley. This was driven from the armature pinion by means of silent chain.

The Northern multi-speed motor enables machine-shop owners to put belted machine tools on a money-making basis, and makes it possible for them to compete with plants employing new motor-driven machine tools. The multi-speed motor affords an opportunity for machine-shop owners to demonstrate for themselves the advantages of individual motor-drive by applying it to some old lathe or other machine tool. The advantage of the Northern system is that the multi-speed motor can be operated from any ordinary two-wire single-voltage power circuit, and electrical variations as high as 5 to 1 easily secured. Where a 5 to 1 electrical variation is accomplished the change gear enables a total variation of 15 to 1. Bulletin No. 454 is descriptive of the multi-speed motor, and will be sent on request.



ELECTRIC MOTOR CONTROLLER.

Electric Motor Control.

THE Rheocrat, shown herewith in half-tone, is designed to control the speed of electric motors, especially in the direct driving of machine tools and other machinery. The advantages claimed for this device are wide and minute range of speed; uniform gradation of speeds; maintenance of motor speeds at all loads when adjusted to any given speed; maintaining of constant torque; economy of operation; adaptability to shop plants without extra wiring and additional generator sets; adaptability to standard designs of motors and machines already in use; ability to stand abuse under severe usage; and low cost of maintenance.

These important advantages are attained by new principles. Instead of introducing resistance in the armature circuit, a simple device makes and breaks the circuit, and the relative change between make and break which determines the amount of impressed electromotive force on the armature constitutes a voltage control through wide range, giving minute changes of speed.

The Rheocrat permits of a range of speeds 3½—1 to 5—1 depending in a measure on the field range of motor. This may, in special cases, be extended to even 10 or 12 to 1. One of the strong points claimed for the Rheocrat is that there is no jump from one speed to another, but a gradual acceleration or diminution of speed between the limits of the armature control; on the other hand any desired gradation in field control can be obtained in addition.

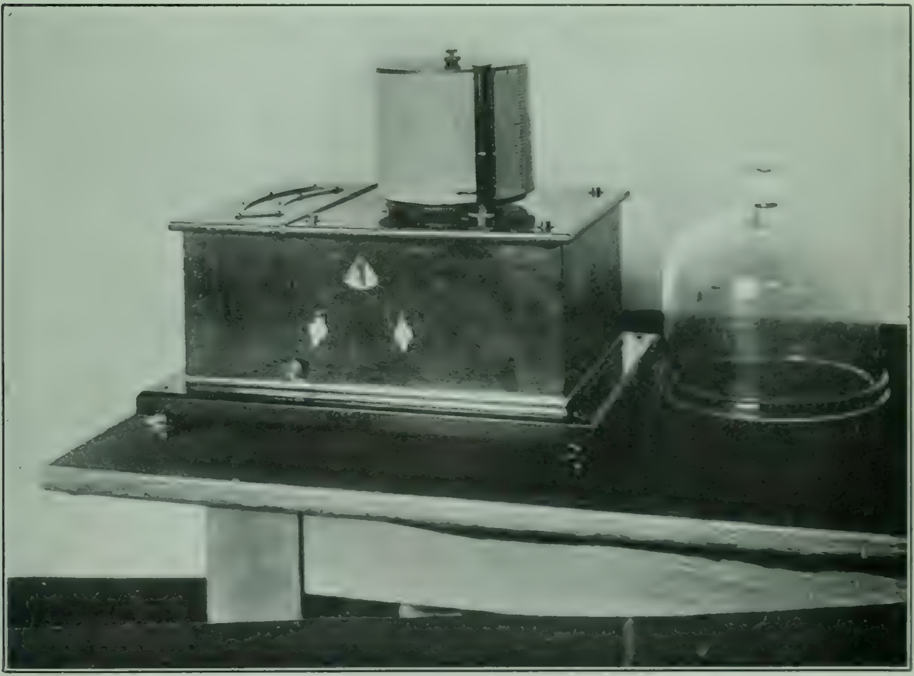
Doubtless the greatest of all objections heretofore advanced against the system of armature control is the fact that at a given speed, especially at a slow speed when a large amount of resistance has necessarily been interposed in the circuit, the speed varies widely under different loads. The Rheocrat, using no resistance, allows the motor to maintain practically constant speed under varying loads.

The manufacturers of the Rheocrat, American Electric and Controller Co., 12 Dey Street, New York, have issued a descriptive bulletin giving many details and the results of a practical demonstration of the device. It will be sent to inquirers on request.

Instantaneous Record of High Temperatures.

A VALUABLE addition to the recording instruments made by Queen & Co., Inc., Philadelphia, is their new recording pyrometer for high temperatures. It is adapted to give a continuous record of temperatures up to 3,000° Fahrenheit. The galvanometer, especially designed for this purpose, is of the d'Arsonval type, and besides presenting the important feature of extreme sensitiveness, is absolutely dead beat. It is, moreover, not in the least affected by vibrations. The recorder is so arranged, that the pen traces on a chart the exact movements of the galvanometer pointer. In the clock which rotates the recording cylinder once in every twenty-four hours, an electric contact is made every minute, whereby an electro-magnet is energized which clamps the pointer of the galvanometer. This, is turn, operates a relay, causing the pen to move up and down until it coincides with the reading of the galvanometer. The pointer then swings entirely free until the next contact is made. The recording device in no way impairs the accuracy or sensibility of the pyrometer. The thermo-electric couple consists of platinum and platinum-rhodium wires three feet long, enclosed in a porcelain protecting tube. Any desired length of wire will, however, be furnished. The indicating instrument is graduated in millivolts and in degrees of temperature.

That the new Queen recording pyrometer is portable, and it gives a continuous record for the whole twenty-four hours, are points

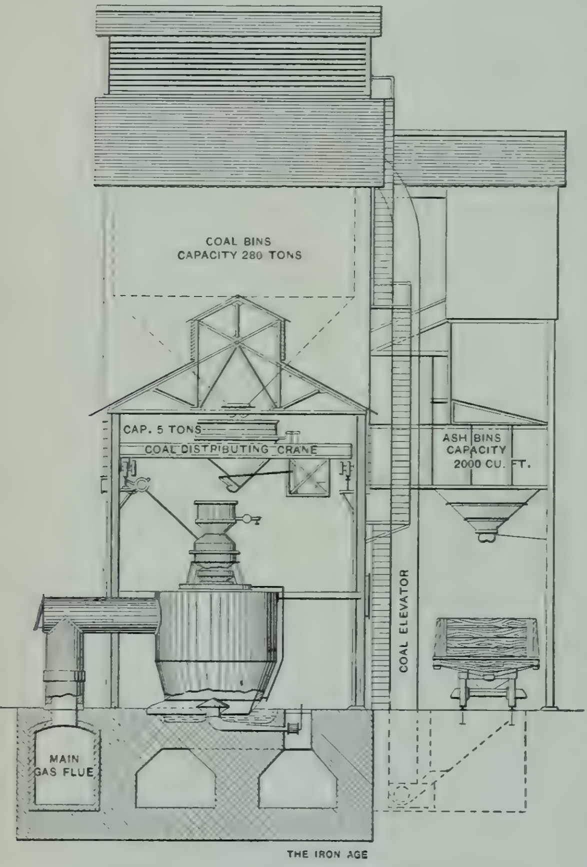


QUEEN RECORDING PYROMETER.

of too great importance to be overlooked. The makers Queen & Co., will furnish details of this and other pyrometers, upon request.

Coaling Gas Producers.

TO provide the most efficient means for coaling a battery of gas producers is sometimes the most serious problem connected with their installation, especially if the plant consists of six or more units. The usual method employed is to build one long overhead bin or a series of smaller bins from which the coal is drawn through spouts at each producer. This plan presents the following objectionable features: (1) Coal at any given part of the bins can only be used in the producer over which it rests; (2) the cost of construction of the bins distributed over a large battery of producers is high; (3) expensive machinery must be employed to distribute the coal over the entire length of the bin, and unless this machinery is in duplicate there is risk of the coal supply running short; and, (4) daily records of coal used cannot be kept, nor can the amount charged to individual producers be ascertained.



THE IRON AGE

SYSTEM OF COALING GAS PRODUCERS.

These difficulties have been avoided in the arrangement recently installed by the Morgan Construction Company, Worcester, Mass., at the plant of the Lackawanna Steel Company in Buffalo, there being a battery of sixteen ten-foot producers in one line, gasifying 175 tons of bituminous coal per day. The illustration on this page exhibits a cross section of the producer house. The coal is received in hopper bottom dump cars alongside and near the center of the plant. Underneath the railroad track a large steel hopper is provided to receive the coal as it discharges from the cars and deliver it to the boot of a coal elevator. The coal is elevated by means of a simple bucket elevator running vertically only and designed to discharge the coal into a central overhead bin having a capacity of 340 tons. The entire coal supply is carried in this one bin and is distributed to the producers as required by a light traveling car running under the central storage bin and over all the producers. The distributing car or crane carries a fixed hopper of five tons capacity, resting on scales. A boy operator, sitting in the cage of the crane, draws a lever and fills the crane tank from the central storage bin and discharges the coal as needed into the receiving hopper of the producer in lots of 1,000 pounds or less. The crane tank carries 10,000 pounds. The beam of the scale is conveniently located in front of the crane cage, and exact coal records are readily made for each producer. The arrangement of large coal tank and distributing crane makes it possible to utilize the last pound of coal in any producer of a large battery and any additional gas units can be served without adding to the coal handling machinery, as one crane would be capable of serving about fifty producers.

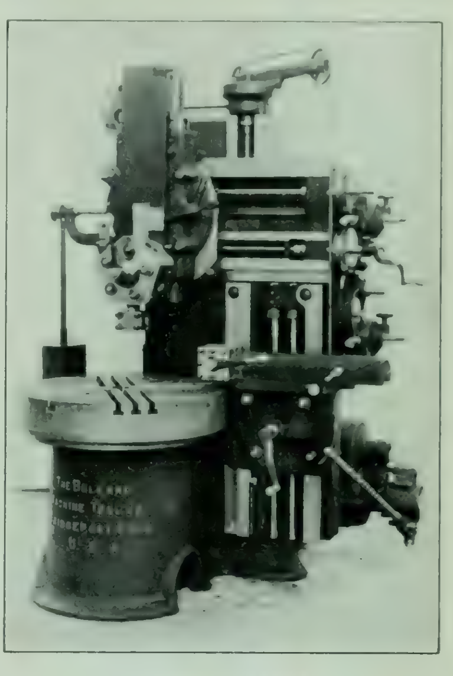
Over the same track on which the coal is received, and within a few feet of where it is dumped from the cars, a large ash reservoir is located, with a capacity of 2,000 cubic feet. The ashes, which are collected by hand from the bottom of the producer, are deposited in a skip bucket, in which they are elevated to the overhead bin. The ashes are taken away in the same cars in which the coal is brought to the plant, thus saving a switch for each car of ashes removed. The entire equipment was built by Morgan Construction Company, Worcester, Mass., from its own designs.

The Vertical Lathe.

FOR the purpose of handling heavy face-plate work of all descriptions, experience has demonstrated the superiority of the vertical mill over the horizontal face plate lathe. Not only is a more rigid frame, or bed, permissible in the vertical construction, and larger spindle sizes and greater power made possible, but the added weight of the work resting directly on the spindle thrust bearing tends to preserve, rather than to destroy, the alignment. There is also an obvious freedom from chatter and vibration in the vertical type, as compared with the horizontal, which can be readily appreciated when the heavy overhanging parts of the latter are considered. This very point of overhang is one of the strongest arguments in favor of the mill, as the time which in the lathe is consumed in setting a heavy overhanging piece is, in the mill, added to the actual time in which the machine can be cutting.

In the horizontal turret machine are usually combined a turret slide, having a longitudinal movement only, and an ordinary lathe carriage. The latter, in many instances, interferes with the proper operation of the turret, and renders necessary the use of long, unsupported boring bars and extended tool holders. The turret, having no cross movement, is of value in a limited field only, and requires an equipment of special tools which, in many cases, result in no saving in time. Taper boring, except with special equipment, is practically impossible in the horizontal turret lathe, and thus the range of the machine is considerably abridged.

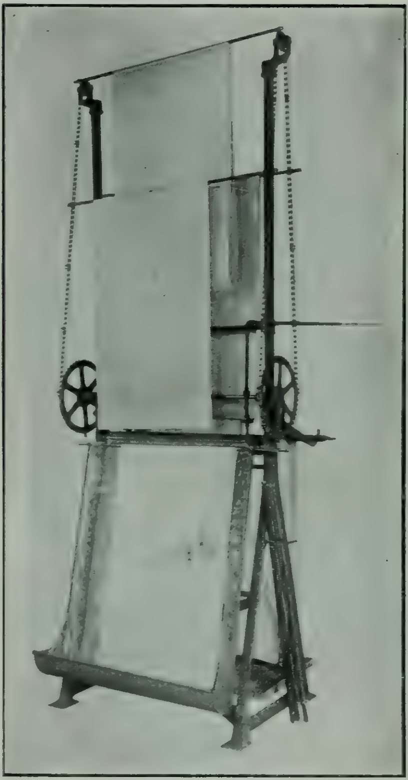
The design of the Bullard vertical turret lathe includes features heretofore found only in the horizontal type, improved upon and incorporated with the most advantageous points of the vertical construction dictated by an experience of more than twenty years in the manufacture of vertical boring and turning mills. The result is a universal manufacturing machine in which several desirable features are noticeable: The vertical construction, with its large spindle and great power, and ease and rapidity of chucking heavy work; a turret slide which is rigid and powerful, having both cross and vertical feeds, and which may be swiveled to 45 degrees either side of the center for taper boring and turning; a side head, carrying a four-faced turret tool holder, which not only has all the advantages which are conceded to the carriage of the horizontal machine,



A VERTICAL LATHE.

including vertical and cross feeds, but may be swiveled for angular facing up to 40 degrees either side of the horizontal; a driving mechanism, which is the result of considerable experiment and includes an exceptionally efficient mechanical speed change, operable by lever at front of tool, from which are derived fifteen geometrically progressive table speeds; feed works, independent for either head, having eight feeds, any one of which may be instantly obtained by turning the star wheel to the proper point on direct reading index plates. Pull gears on feed rods have been entirely eliminated, worm gears, keyed to the rods, having superseded them. Changes from cross to vertical feed, or vice versa, are made by engaging a centrally located drop worm. Safety points have been so arranged in the feeds that carelessly permitting the heads to run together results in no damage or delay. Both heads may be operated jointly on work of small diameter without interference—this feature presenting the greatest advantage in the machine, and resulting in an increase of output.

The Bullard Machine Tool Co., Bridgeport, Conn., will furnish full description and other details to machine-tool men.



BLUE PRINT WASHER.

Blue Print Washing and Drying Machine.

A NEW blue print washing and drying machine, the Pease, is illustrated herewith. The washing of the prints is accomplished by a spray of running water flowing over the treated side of the paper only, removing the surplus ferroprussiate in the quickest time possible. Prints are not soaked through as in the old process, as the water coming in contact with one side of the paper only and for but a very short time, leaves it in a condition to dry in about one-third of the time usually required. The delivery therefore is greatly expedited.

The print is placed on the drying rod before washing and remains there during the entire process of washing, wiping and drying, making it unnecessary for the operator to wet his hands. He can, therefore, work to and from printer and washer without difficulty, washing sheets as fast as printed, as the time required at the machine is but a fraction of a minute. As it hangs in the washing tray on the drying rod, the water flows down both sides of the doubled print, half of it on the side toward the operator and the rest between the print and the back of the tray. When the front portion of the print in view of the operator is completely washed the balance is always in the same condition.

The surplus water is removed by a device which wipes the print as it is moved upward out of the way on the drying chains. As the next print is pulled through the wiping device the previous one is carried still higher and over the top, and finally downward until it is automatically stripped from the chains of the machine, falling into a drying rack from which the dry prints may be removed as required.

The manufacturer is C. F. Pease, 175 West Locust Street, Columbus, Ohio, who will furnish fuller details on request.

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Factory and industrial management

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